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# **Dillon Resource Area Resources Inventory:**

## **Water Quality Survey Rochester Unit**

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DILLON RESOURCE AREA  
RESOURCES INVENTORY:

WATER QUALITY SURVEY  
Rochester Unit

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## ACKNOWLEDGEMENTS

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## INTRODUCTION

Watershed managers have traditionally been concerned with the quality of the waters that leave a watershed. As man modifies watersheds by various land use practices, disequilibrium in both the terrestrial and aquatic environments occurs. Problems result in controlling accelerated sediment and nutrient release from non-point sources within the basin. Stream water samples provide the investigator with insights into the general health of the patient. In an attempt to reduce watershed degradation, Congress recently mandated that local and regional agencies and authorities gather and assess environmental data for the lands and waters under their jurisdiction and authority. The Federal Water Pollution Control Act Amendments of 1972 (Public Law 92M-500) was promulgated to require:

- 1) the assessment of the sources and extent of non-point pollution, and
- 2) the development of methods and procedures for controlling non-point pollution resulting from agricultural and silvicultural activities (FWPCA, 1972).

In April, 1976, personnel from the Montana Forest and Conservation Experiment Station began a resource inventory in southwest Montana for the Bureau of Land Management. This integrated resources inventory was designed by Bureau personnel to provide environmental data on watershed, wildlife, and range resources within portions of Beaverhead, Deer Lodge, Madison and Silver Bow counties near Dillon, Montana. More specifically, the National Resource Lands in the Rochester, Blacktail, Tendoy Mountains, Dillon West, and Centennial Planning Units were inventoried. The environmental data obtained is to be incorporated into the Bureau's Planning System and into the Mountain Foothills Range Environmental Impact Statement.



The water quality study portion of the above resource inventory project included the monitoring of 42 temporary stream sampling stations located in 17 drainage basins within the inventory area. Stream discharge, suspended sediment, hydrochemical values and bacteria levels were monitored at each sampling station for the 1977 and 1978 hydrologic years. In addition, the macrobenthic invertebrate communities at each station were sampled, the results of which are reported elsewhere. This volume presents the results of the water quality study for Rochester Planning Unit which includes MacLean, Moose, and Camp Creeks.



## METHOD

The basic experimental design of the water quality study, developed by Bureau personnel, includes the sampling scheme, field methods, and laboratory methods. Minor additions and modifications to the original design were subsequently incorporated into the study as field and laboratory conditions dictated or permitted. Specific comments on such alterations are included.

### Inventory Design

The initial phase of the water quality study involved a stream reach inventory and channel stability evaluation of each designated stream reach. The method and procedures used during this evaluation are outlined in Pfankuch (1975). The stream reach ratings were completed during August and September, 1976.

The 42 stream sampling stations were established during September, 1976. The selection of each gaging station site was governed by criteria presented in Carter and Davidian (1968). Each stream sampling station included a staff gage, a crest-stage gage, and a max-min thermometer. A standard 3.3ft. staff gage was mounted to a fence post driven into the stream bed. A crest-stage gage was constructed of 3/4" diameter clear acrylic tubing, using modifications of the plans set forth in Buchanan and Somers (1968). This gage was affixed to the staff gage and fence post. The max-min thermometer was bolted within a piece of PVC pipe, laid on the stream bottom, and attached by a chain to a fence post.

In addition, a 15 unit precipitation gage network was established in the spring of 1977. A general purpose rain gage (forester type) was installed in a plywood frame at each designated sample location and placed in a clear, open site at a 12" height above ground level. This technique



conforms with that recommended by the World Meteorological Organization (World Meteorological Organization, 1969, as cited in Aldridge, 1976). Such a placement minimizes the error caused by wind eddying (Stringer, 1972, p. 29; Aldridge, 1976), and reduces the probability of disturbance or damage by livestock or vandals.

The stream and precipitation gage networks were monitored during the 1977 and 1978 hydrologic years. The basic design called for all stations to be visited on a prescribed schedule of weekly during peak runoff and monthly during low flow. The field seasons included: October - November, 1976; February and April - November, 1977; and March - September, 1978. The following water quality parameters were monitored as applicable. During each visit; stream discharge, suspended sediment, specific conductance, air temperature, water temperature, max-min water temperature, and precipitation were determined. Once a month, a water quality sample was taken for the following analyses: pH, alkalinity, calcium, magnesium, sodium, potassium, bicarbonate, sulfate, ammonia, nitrite-nitrate, and ortho-phosphate. A second stream water sample was obtained for bacterial analysis to determine levels of total and fecal coliform.

Macrobenthic invertebrate inventories were also conducted at each stream sampling station during May, July, and September of each hydrologic year. Four individual square foot samples for the smaller streams and 6 samples for the larger streams were obtained during 1977, while 2 and 4 samples respectively were obtained for the streams during 1978.

#### Field Methods

Discharge values were determined by standard techniques using procedures described in Buchanan and Somers (1968). Stream velocities



were taken with a Gurley Pygmy type model 625 current meter. Sediment samples were obtained with a US DH-48 sediment sampler in conformance with procedures in Guy and Norman (1970). Water temperatures were recorded from Taylor max-min thermometers. Precipitation was collected in standard 7" rain gage (forester type). Specific conductance was measured with a Delta Scientific Model 1914 conductivity meter. Hydrochemical samples were collected in acid washed polyethylene liter bottles, which were filled to exclude air, and stored in an ice chest during transport to the laboratory. Microbiological samples were collected in 250 ml sterilized glass bottles and also stored in the ice chest. The macrobenthic invertebrate samples were taken with a Kahlsico stream-bed fauna sampler.

#### Laboratory Methods

Immediately upon arrival at the Dillon laboratory, each sample bottle was opened and an unfiltered sample was analyzed for pH and alkalinity respectively. The values obtained closely represent the values at the time of collection in the field (Brown, Skougstad, and Fishman, 1970, p. 129), while minimizing the potential for instrument damage during transport or carriage over back country roads or trails. This method has been adopted by several USDA Forest Service personnel (Aubertin, 1974; Snyder, et al., 1975). PH was measured using an Orion pH probe and an Orion 407 ion analyser. Akalinity was then determined by potentiometric titration to a preselected end point with a standard acid, as outlined in Brown, et al., (1970).

A 100 milliliter aliquot for ammonia analysis was then acidified with 0.8 milliliter concentrated sulfuric acid and refrigerated (American



Public Health Assoc., 1976, p.42). The remainder of each stream sample was subsequently filtered through a  $0.45\ \mu\text{m}$  (micrometer) membrane filter and frozen. Membrane filters were soaked for 24 hours before using to remove any traces of soluble phosphate or nitrate (A.P.H.A., 1976 p. 472). Ammonia samples were analyzed on an Orion Ammonia electrode, model 95-10 (Orion Research Incorp., 1974). This analysis was routinely preformed in the Dillon laboratory on the final day of field collection.

Upon return to the Missoula laboratory the frozen samples were defrosted for analysis in the following order; 1) filterable orthophosphate; 2) nitrite-nitrate; 3) sulfate; and 4) common metals. Procedures followed were adapted from Standard Methods for the Examination of Water and Wastewaters (A.P.H.A, 1976), with the exception of nitrate which was taken from Methods for Chemical Analysis of Water and Wastes (Environmental Protection Agency, 1976). All colorimetric tests were preformed on a dual beam spectrophotometer (Beckmann ACTA model III). All glassware was acid washed.

The Asorbic Acid method, procedure 425F, (A.P.H.A., 1976) was used for dissolved orthophosphate. Results are expressed as  $\text{PO}_4\text{-P}$ . Nitrite and nitrate were determined collectively since nitrite usually occurs in insignificant amounts in uncontaminated surface waters. The sum of the two represents total oxidized nitrogen and is expressed as nitrite plus nitrate-nitrogen. The Cadmium Reduction Method (E.P.A., 1976) was selected because of its low detection limits ( $10\ \mu\text{g/l}$ ). Sulfate was measured using the turbidimetric method, procedure 427C, (A.P.H.A., 1976). During the 1977 field season measurements were made on a spectrophotometer, but during 1978 a nephelometer (Turner Designs, Inc., model #40) was used. Both



methods are recommended in the procedure, although it was found the nephelometer increased the precision of the test. Sodium, potassium, magnesium and calcium were run in that order by atomic absorption spectroscopy (A.P.H.A., 1976) using a Varian Techtron AA-5 spectrophotometer. Lanthanum chloride solution was added to the samples for magnesium and calcium analyses to prevent anionic interferences (EPA, 1976). Total dissolved solids and bicarbonate concentrations were determined from specific conductance and alkalinity values using calculations presented in Brown, et al., (1970).

Nitrogen levels, ie. ammonia and nitrite-nitrate, are consistently at the minimum detection limit of the analysis. Ammonia levels are particularly suspect owing to the limitations of the instrument and the technique for the analysis. In interpreting results of ammonia analysis; a presence or absence of detectable ammonia approach should be used. Thus high levels of ammonia indicate that a source of ammonia is present in addition to those which are naturally occurring. Such levels are usually transitory and may vary in order of magnitude. Nitrite - nitrate values are also near the minimum detection limit; however, the nature of this analysis yields more precise results. These values, as a whole, tend to be generally lower than those expected under the environmental conditions encountered. Low phosphate values are to be expected and were confirmed by this study. The method for phosphate analysis selected is the procedure generally used when working in this low range of values. The other ions, ie. sulfate and the common metals, tended to be present in sufficient quantities so that no problems were encountered owing to the sensitivity of the analyses.

Water samples for microbiological examination were analyzed within six hours of collection (Millipore, 1975a). Fecal coliform were cultured, identified, and enumerated throughout the study by the membrane filter method described by Millipore (1975b). Total coliform bacteria were cultured,



identified, and enumerated by the membrane filter method (Millipore, 1975a), but with the modifications outlined below.

Total coliform data for 1977 were determined by counting the number of wet colonies that exhibited a visible green metallic sheen, either to the naked eye or at 1.5x magnification. Millipore (1975a) recommends the use of a 10x magnification dissecting microscope and that the colonies be dry. Geldreich (1975), however, indicates that there is no significant advantage to drying the colonies before counting. Without the 10x magnification, however it is probable that colonies growing close together were mistaken as being one colony, and colonies having a weak metallic sheen were not counted at all. This procedure would result in data that would underestimate the number of total coliform colonies present.

A modification of the membrane filter method was adopted in 1978 to minimize the problem of underestimating the total coliform colonies. In the previous year, only the wet colonies exhibiting a distinct green metallic sheen were designated as coliform bacteria (Millipore, 1975a), while those wet colonies having a "non-sheen" red color darker than the medium-permeated background had not been counted. The degree of pigmentation and sheen development of coliform colonies grown on M-Endo medium, however, is variable according to both species and biotype. Furthermore, the identification criteria, i.e. colonies having a green iridescence or metallic sheen, is highly subjective and may vary from technician to technician. Thus, some authors admit that "questionable colonies" may occur which need more technical procedures for verification. One such procedure is to inoculate questionable colonies into a lactose broth, incubate at 35°C. for 48 hours, and determine whether gas and acid have been produced (Geldreich, 1975).



Using the above technique, an estimate of the fraction of questionable colonies was determined for which the lactose test was positive. After testing a series of 26 non-sheen, red colonies representing a variety of recognizable colonial morphotypes from several different stations, 69 percent were found to be lactose positive within 48 hours. Additionally, 16 percent of all dark red colonies found on 369 membrane filter samples exhibited a characteristic green sheen. It was thus estimated that approximately 75 percent of all red colonies darker than their membrane filter background conformed to either the green-sheen or lactose-test definitions of coliform bacteria. During the 1978 field season, all red colonies, sheen and non-sheen darker than their membrane filter background that were detected with the use of 10x magnification dissecting microscope were counted as total coliform. This procedure had the potential of overestimating the bacterial count by approximately 30 percent. It should be emphasized, however, that bacterial counts are not absolute values, but only estimates of magnitudes. Geldreich (1966, p.35) evaluated the total coliform bacteria for 40 samples using both the membrane filter method and the "most probable number" method. The ratio of their results varied from a minimum of 0.42 to a maximum of 2.52 respectively.

Tabulated total and fecal coliform data for this study are expressed as arithmetic means of either two or three replicated subsamples. Although the total coliform levels for the 1977 field season, i.e. May through November, 1977, are underestimated, the fecal coliform data for the two years are commensurate.



### Analytical Methods

Stream discharge values were determined from field data with the use of a computer program based upon the procedure outlined in Buchanan and Somers (1969). These measured discharge values were then used to generate a staff-discharge rating curve for each station using a linear regression program. In several instances, two rating curves were produced. Instant and crest stage discharge values for the two water years were then estimated from the respective staff-discharge rating curves.

The annual hydrograph and sediment loading graphs were plotted with a computer using field data. Missing data points, i.e. winter months, were estimated using available stream flow, precipitation, and sediment concentration data. Estimates of annual water yield and annual sediment yield were generated by a modification of the computer program used to determine stream discharge. In a few instances, unusually high or questionable sediment concentration values, apparently caused by cattle present within the stream environs at the time of sampling or by sampling or analytical error, represented long sampling periods, i.e. 30 days. Where such conditions occurred, an estimated "corrected" level was substituted in order to generate a more approximate determination of the annual sediment yield. The relationships between measured values of suspended sediment vs stream discharge and specific conductance vs stream discharge were determined by linear regression and plotted using the computer programs.



## STUDY AREA

### Beaverhead County, Montana

Beaverhead County is located in the southwestern corner of Montana immediately southwest of Butte. Almost the entire county lies above 5,000 feet and is encircled on the north, west, and south by the Continental Divide. The area is characterized by broad grassland and sagebrush covered valley bottoms and river terraces, while the flanks of the numerous mountain ranges grade into forest lands. The westernmost headwaters of the Missouri River drain the county to the northeast via the Big Hole and Beaverhead rivers. The forested mountain areas are generally administered by the Beaverhead National Forest of the USDA, Forest Service; the lower mountain slopes and terrace lands are managed by the Department of Interior's Bureau of Land Management; while the valley bottoms are mainly in private holdings. The land resources of the county are primarily allocated to the raising of livestock, although lumbering, mining, and recreation constitute secondary, but significant land uses.

The Bureau of Land Management's district office is located in the county seat of Dillon. The Bureau administers a number of planning units within the county. The Rochester Planning Unit lies north of Dillon and includes the Camp Creek and Moose Creek sample watersheds.

### Camp Creek Watershed

The Camp Creek sample basin (Figure 1) encompasses approximately 21,100 acres and includes the Lower Camp and Upper Camp sample stations.



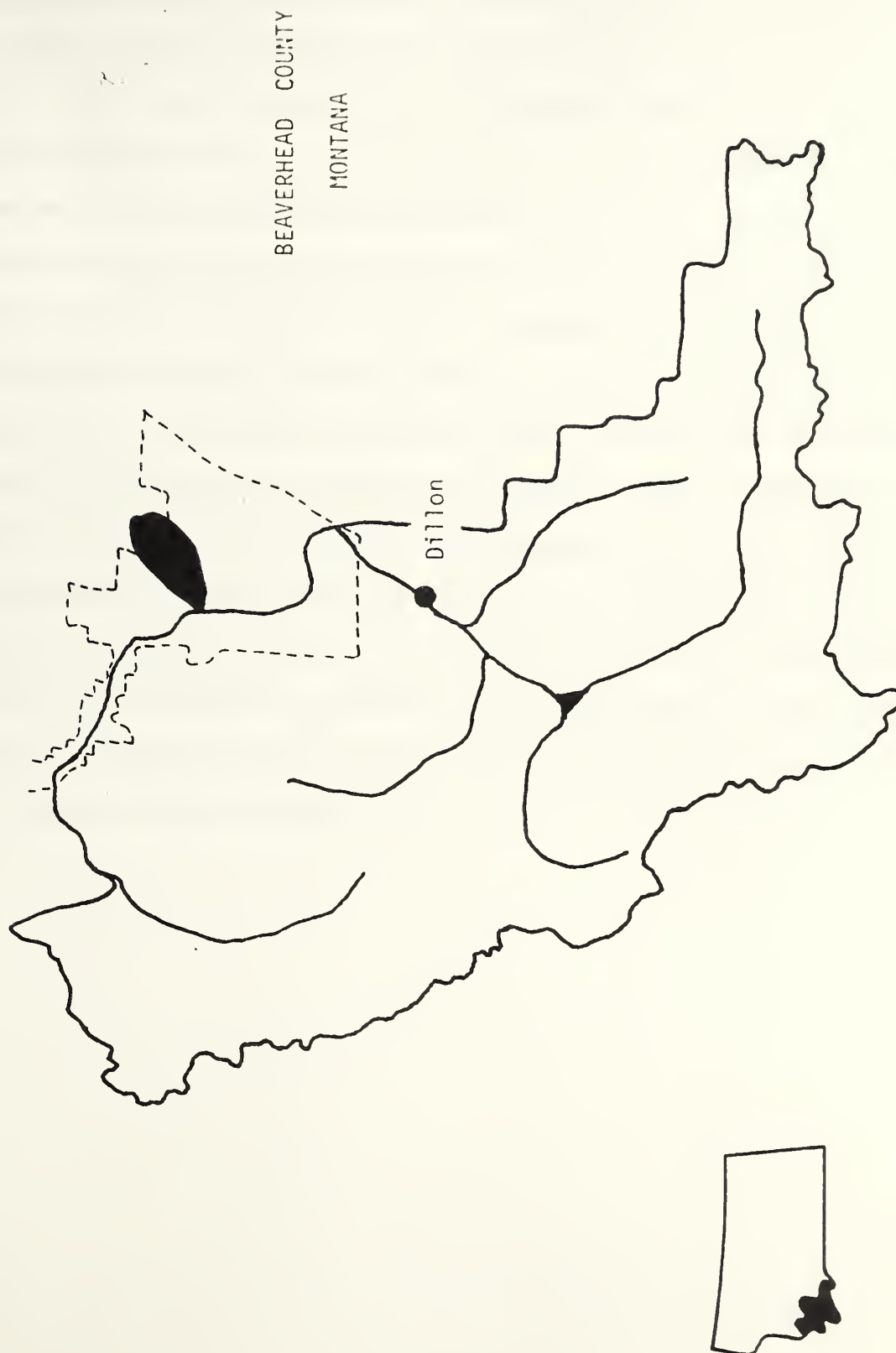


FIGURE 1 Location of Camp Creek Watershed, Rochester Planning Unit, Beaverhead County, Montana



Local relief within this southwest oriented basin ranges from 5,500 feet to over 10,100 feet elevation. The upper basin includes a steeply walled open valley, while the middle and lower reaches of the basin are generally confined between moderate to steep slopes. The basin geology is primarily composed of sedimentary and metasedimentary materials. The soils are predominantly entisols and inceptisols in the steeper areas, while mollisols characterize the more gentle sections. Approximately 30 percent of the watershed is forested, the major portion being along the steep north facing slopes and on the slopes of the upper valley. Sagebrush and grassland communities dominate the remainder of the basin. About 50 percent of the basin is managed by the Bureau of Land Management, 30 percent by the Deer Lodge National Forest, 15 percent is in private holdings, and 5 percent is owned by the State of Montana. Portions of the basin were mined during the last century, and there is currently some active lumbering in the upper reaches of Little Camp Creek, but livestock grazing is the dominant land use throughout the watershed.



### Lower Camp Station

The Lower Camp station No. 1 is located in the north central portion of Section 20, Township 2S, Range 8W (Figure 2), approximately 500 yards upstream from the reservoir. This location is found on the Wickiup Creek, Montana 7.5 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 1 on aerial photo No. 6-102-132 of this resource inventory report, and is shown on stream station photo no. 1A. The station is located at 5,540 ft. elevation. The watershed above the station contains approximately 21,100 acres, has a local relief of 4,600 feet, and is oriented to the southwest. Approximately 30 percent of the watershed is forested.

### Upper Camp Station

The Upper Camp station No. 2 is located on the north central portion of Section 1, Township 2S, Range 8W (Figure 2), approximately 200 yards downstream from the confluence of Camp and Wickiup creeks. This location is found on the Wickiup Creek, Montana 7.5 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 2 on aerial photo No. 13-100-57 of this resource inventory report, and is shown on stream station photo no. 2A. The station is located at 6,250 feet elevation. The watershed above the station contains approximately 11,400 acres, has a local relief of 3,900 feet, and is oriented to the south. Approximately 70 percent of the watershed is forested.

The Upper Camp precipitation station No. 2G is located in the north central portion of Section 1, Township 2S, Range 8W (Figure 2).





FIGURE 2 Location of the Lower Camp and Upper Camp Sampling Stations and the Upper Camp Precipitation Station.



The gage is on the lower slope of the left bank, approximately 75 yards upstream from where the road crosses Camp Creek. The site is depicted as site No. 2G on aerial photo No. 13-100-570 of this resource inventory report.

#### Moose Creek Watershed

The Moose Creek sample watershed (Figure 3) encompasses approximately 23,300 acres and includes the Lower Moose, Upper Moose and MacLean sample stations. The basin has a generally southwest aspect and ranges in elevation from 4,400 feet to slightly over 10,000 feet elevation. The upper watershed contains several broad valleys with meandering streams and numerous beaver ponds. Moderate to steep and rocky slopes dominate the middle and lower reaches of the watershed, especially within and peripheral to the Humbug Spires Primitive Area. The upper Moose Creek basin is underlain by granitic parent rock, while the lower basin includes sedimentary and metasedimentary parent materials. The dominant soils of the basin are entisols and inceptisols, although there are some mollisols in the lower reaches of the basin and in scattered areas. Approximately 90 percent of the basin is covered with forests, with the remainder in sagebrush and grassland communities. The Deerlodge National Forest administers about 50 percent of the basin, 35 percent is managed by the Bureau of Land Management, and 15 percent is private land. Portions of the upper basin were mined during the last century. Currently there is some logging in the upper valley, but livestock grazing and recreation are common throughout the basin.



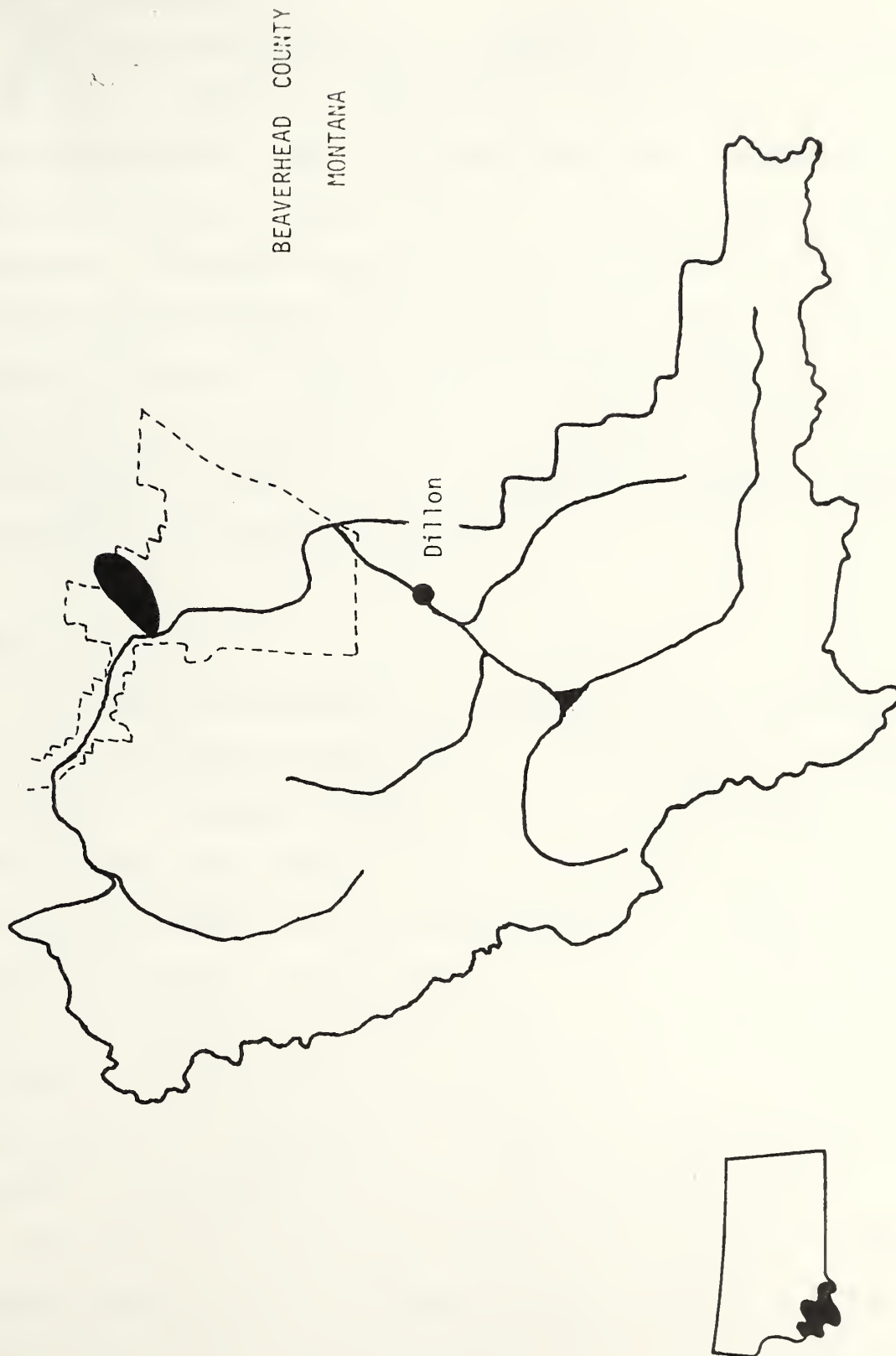


FIGURE 3 Location of Moose Creek Watershed, Rochester Planning Unit, Beaverhead County, Montana



#### Lower Moose Station

The Lower Moose station No. 5 is located in the southeastern portion of Section 23, Township 1S, Range 9W (Fig. 4), approximately 100 yards above the confluence of Moose Creek and Chicken Gulch. This location is found on the Melrose, Montana 7.5 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 5 on aerial photo No. 13-100-53 of this resource inventory report, and is shown on stream station photos no. 5A and no. 5B. The station is located at 5,660 feet elevation. The watershed above the station contains approximately 23,300 acres, has a local relief of 4,400 feet, and is oriented to the southwest. Approximately 70 percent of the watershed is forested.

#### Upper Moose Station

The Upper Moose station No. 3 is located in the west central portion of Section 9, Township 1S, Range 8W (Fig. 4), approximately 10 yards downstream from the confluence of Moose Creek and an unnamed stream entering from the south. This location is found on the South Butte, Montana 15 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 3 on aerial photo No. 14-99-4 of this resource inventory report, and is shown on stream station photo no. 3A. The station is located at 6,600 ft. elevation. The watershed above the station contains approximately 15,400 acres, has a local relief of 3,500 feet, and is oriented to the southwest. Approximately 80 percent of the watershed is forested.

The Upper Moose precipitation station No. 3G is located in the south central portion of Section 9, Township 1S, Range 18W (Fig. 4). The gage is approximately 50 yards upslope and slightly to the left of the junction of the MacLean Creek road and the ridge road leading down to the Upper Moose



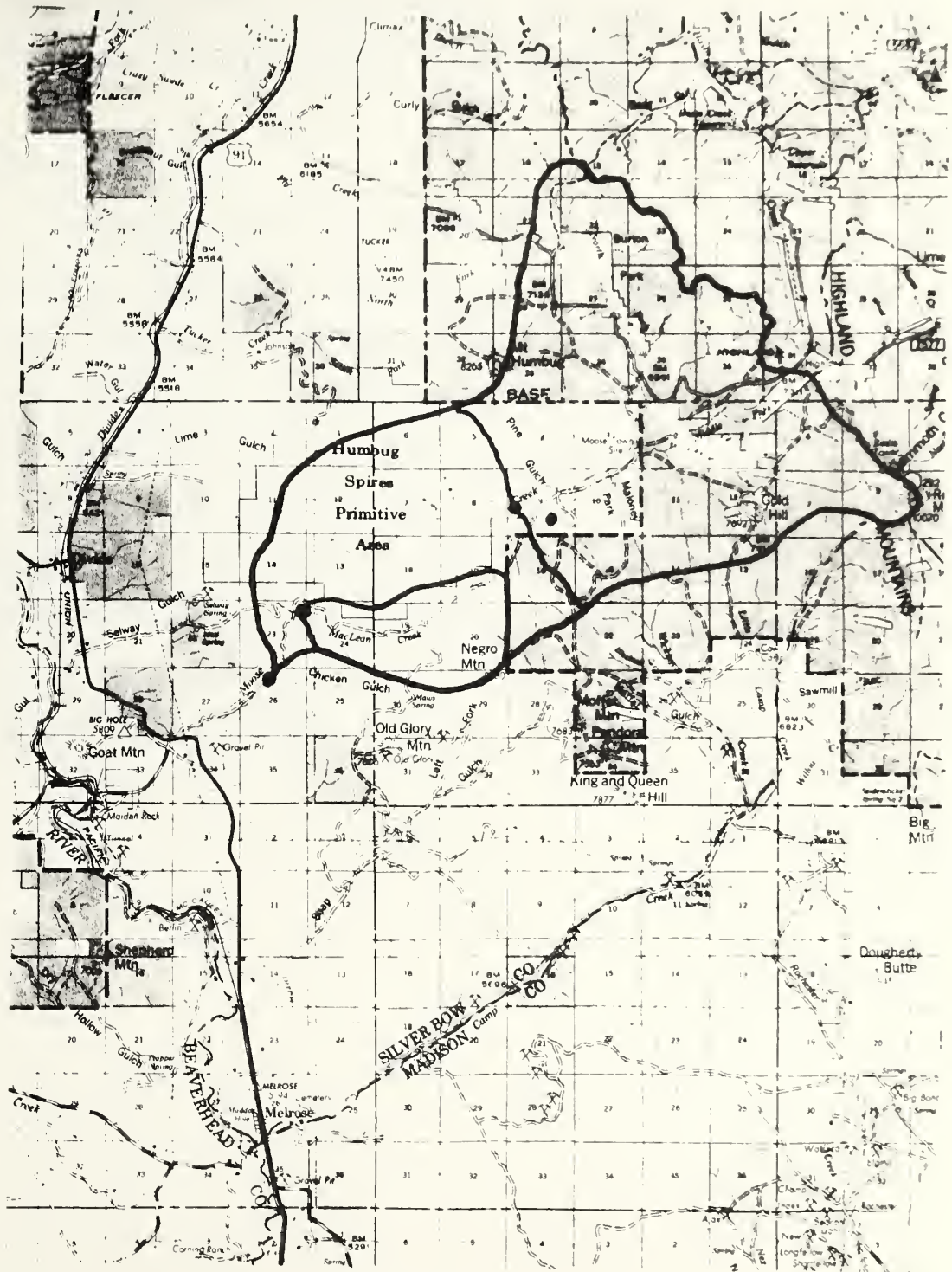


FIGURE 4 Location of Lower Moose, Upper Moose, and MacLean Sampling Stations and Upper Moose Precipitation Station.



stream gaging station. The precipitation station is depicted as site No. 3G on aerial photo No. 14-99-4 of this resource inventory report.

#### MacLean Station

The MacLean station No. 4 is located in the northeastern portion of Section 23, Township 1S, Range 9W (Fig. 4), approximately 15 yards upstream from the confluence of MacLean and Moose creeks. This location is found on the Melrose, Montana 7.5 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 4 on aerial photo No. 13-100-53 of this resource inventory report, and is shown on stream station photo no. 4A. The station is located at 5,780 ft. elevation. The watershed above the station contains approximately 2,560 acres, has a local relief of 2,600 feet, and is oriented to the west. Approximately 90 percent of the watershed is forested.



## RESULTS AND DISCUSSION

The results of the water quality survey of the Camp and Moose Creek sample basins of the Rochester Planning Unit are summarized and briefly discussed below. The basic data for each station is found in the Appendix of this volume.

### Camp Creek Basin

The Camp Creek sample basin was visited a total of 16 and 20 times during the two hydrologic years. There were no specific accessibility or sampling problems. The Upper Camp station was monitored 15 and 18 times respectively.

#### Channel Stability Ratings

The Upper Camp Creek, Little Camp Creek, and Wickiup Creek stream sections were evaluated on August 12, 1976. The portion of Camp Creek between the reservoir and the confluence of Camp and Wickiup creeks was evaluated independently by Bureau personnel. The upper segment of Camp Creek was rated as 'good' (70) (Table 1), Little Camp Creek as 'good' (53) (Table 2), and Wickiup Creek as 'good' (75) (Table 3). Since the inventory, conditions along lower Wickiup Creek have deteriorated owing to the diversion of the creek down portions of the road by a large beaver dam.

#### Precipitation

Precipitation was measured at the Upper Camp precipitation station from April 30 through November 10, 1977 and from April 5 through September 12, 1978. The general precipitation patterns during these two fiscal years



Table 1

## R-1 STREAM CHANNEL STABILITY FIELD EVALUATION FORM

Upper Camp Creek  
8/12/76

Item Rated	Stability Indicators by Classes							
	EXCELLENT		GOOD		FAIR		POOR	
<b>I. UPPER BANKS</b>								
Landform Slope	Bank slope gradient <30%.	Bank slope gradient 30-40%.	Bank slope gradient 40-60%.	Bank slope gradient 60% +				8
Mass Wasting (Existing or Potential)	No evidence of past or potential for future mass wasting into channels.	Infrequent and/or very small, mostly healed over. Low future potential.	Moderate frequency & size, by water during high flows.	Frequent or large, causing imminent danger of same.				12
Debris Jam Potential (Floatable Objects)	Essentially absent from immediate channel area.	Present but mostly small twigs and limbs.	Present, volume and size are both increasing.	Moderate to heavy amounts, predominantly larger sizes.				8
Bank Protection from Vegetation	90% + plant density. Vigor and variety suggests a deep, dense root mass.	70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.	50-70% density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.	<50% density plus fewer species & less vigor indicate poor, discontinuous, and shallow root mass.				12
<b>II. LOWER BANKS</b>								
Channel Capacity	Ample for present plus some increases. Peak flows contained, W/D ratio <7.	Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8-15.	Barely contains present floods. Occasional overbank floods, W/D ratio 15-25.	Inadequate. Overbank flows common. W/D ratio >25.				4
Bank Rock Content	65% + with large, angular boulders 12" + numerous.	40 to 65%, mostly small boulders to cobble 6-12".	20 to 40%, with most in the 3-6" diameter class.	<20% rock fragments of gravel sizes, 1-3" or less.				87
Obstructions Flow Deflectors Sediment Traps	Rocks, old logs firmly embedded. Flow pattern of pool & riffles stable without cutting or deposition.	Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors never and less firm.	Moderately frequent, moderately unstable obstructions & deflectors move with high water causing bank cutting and filling of pools.	Frequent obstructions and deflectors cause bank erosion yearlong. Sed. traps full, channel migration occurring.				8
Cutting	Little or none evident. Infrequent raw banks less than 6" high generally.	Some, intermittently at outcrops & constrictions. Raw banks may be up to 12".	Significant. Cuts 12"-24" high. Root mat overhangs and sloughing evident.	Almost continuous cuts, some over 24" high. Failure of overhangs frequent.				16
Deposition	Little or no enlargement of channel or point bars.	Some new increases in bar formation, most from coarse gravels.	Moderate deposition of new gravel & coarse sand on old and some new bars.	Extensive deposits of predominantly fine particles. Accelerated bar development.				16
<b>III. BOTTOM</b>								
Rock Angularity	Sharp edges and corners, plane surfaces roughened.	Rounded corners & edges, surfaces smooth & flat.	Edged in two dimensions.	Well rounded in all dimensions, surfaces smooth.				4
Brightness	Surfaces dull, darkened, or stained. Gen. not "bright".	Mostly dull but may have up to 35% bright surfaces.	Mixture, 50-50% dull and bright, ± 15%, ie 35-65%.	Predominately bright, exposed or scoured surfaces.				4
Consolidation or Particle Packing	Assorted sizes tightly packed and/or overlapping.	Moderately packed with some overlapping.	Mostly a loose assortment with no apparent overlap.	No packing evident. Loose assortment, easily moved.				8
Bottom Size Distribution	No change in sizes evident. Stable materials 80-100%.	Distribution shift slight. Stable materials 50-80%.	Moderate change in sizes. Stable materials 20-50%.	Marked distribution change. Stable materials 0-20%.				16
Scouring and Deposition	Less than 5% of the bottom affected by scouring and deposition.	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	30-50% affected. Deposits & scour at obstructions, constrictions, and bends. Some filling of pools.	More than 50% of the bottom in a state of flux or change yearlong.				24
Clinging Aquatic Vegetation (Moss & Algae)	Abundant. Growth largely moss like, dark green, perennial. In swift water too.	Common. Algal forms in low velocity & pool areas. Moss here too and on after waters.	Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.	Perennial types scarce or absent. Yellow-green, short term bloom may be present.				4
COLUMN TOTALS -- 7 -- 48 -- 8								7

Add the values in each column for a total reach score here. (E. 7 + G. 48 + P. 8 + P. 7 = 70).

Reach score of: &lt;30=Excellent, 39-76=Good, 77-114=Fair, 115+=Poor.

RI-2500-3 (6)



Table 2

## R-1 STREAM CHANNEL STABILITY FIELD EVALUATION FORM

Little Camp Creek  
8/12/76

Item Rated	Stability Indicators by Classes			
	EXCELLENT	GOOD	FAIR	POOR
<b>I. UPPER BANKS</b>				
Bank Slope	Bank slope gradient <30%. No evidence of past or potential for future mass wasting into channels.	Bank slope gradient 30-40%. Infrequent and/or very small future potential.	Bank slope gradient 40-60%. Moderate frequency & size, with some raw spots eroded by water during high flows.	Bank slope gradient 60% +. Frequent or large, causing imminent danger of same.
Mass Wasting (Existing or Potential)	Essentially absent from immediate channel area.	Present but mostly small twigs and limbs.	Present, volume and size are both increasing.	Moderate to heavy amounts, predominantly larger sizes.
Debris Jam Potential (Floatable Objects)	90% + plant density. Vigor and variety suggests a deep, dense root mass.	70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.	50-70% density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.	<50% density plus fewer species & less vigor indicate poor, discontinuous, and shallow root mass.
Bank Protection from Vegetation				
<b>II. LOWER BANKS</b>				
Channel Capacity	Ample for present plus some increases. Peak flows contained. W/D ratio <7.	Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8-15.	Barely contains present peaks. Occasional overbank floods. W/D ratio 15-25.	Inadequate. Overbank flows common. W/D ratio >25.
Bank Rock Content	65% + with large, angular boulders 12" + numerous.	40 to 65%, mostly small boulders to cobble 6-12".	20 to 40%, with most in the 3-6" diameter class.	<20% rock fragments of gravel sizes, 1-3" or less.
Obstructions	Rocks, old logs firmly embedded. Flow pattern of pool & riffles stable without cutting or deposition.	Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm.	Moderately frequent, moderately unstable obstructions & deflectors move with high water causing bank cutting and filling of pools.	Frequent obstructions and deflectors cause bank erosion yearlong. Sed. traps full, channel migration occurring.
Flow Deflectors				
Sediment Traps				
Cutting	Little or none evident. Infrequent raw banks less than 6" high generally.	Some, intermittently at outcrops & constrictions. Raw banks may be up to 12".	Significant. Cuts 12"-24" high. Root mat overhangs and sloughing evident.	Almost continuous cuts, some over 24" high. Failure of overhangs frequent.
Deposition	Little or no enlargement of channel or point bars.	Some new increases in bar formation, most from coarse gravels.	Moderate deposition of new gravel & coarse sand on old and some new bars.	Extensive deposits of predominantly fine particles. Accelerated bar development.
<b>III. BOTTOM</b>				
Rock Angularity	Sharp edges and corners, plane surfaces roughened.	(1) Rounded corners & edges, surfaces smooth & flat.	(2) Corners & edges well rounded in two dimensions.	(3) Well rounded in all dimensions, surfaces smooth.
Brightness	Surfaces dull, darkened, or stained. Gen. not "bright".	(1) Mostly dull but may have up to 35% bright surfaces.	(2) Mixture, 50-50% dull and bright, $\pm 15\%$ , i.e. 35-65%.	(3) Predominately bright, 65% +. Exposed or scoured surfaces.
Consolidation or Particle Packing	Assorted sizes tightly packed and/or overlapping.	(2) Moderately packed with some overlapping.	(3) Mostly a loose assortment with no apparent overlap.	(6) No packing evident. Loose assortment, easily moved.
Bottom Size Distribution	No change in sizes evident. Stable materials 80-100%.	(4) Distribution shift slight. Stable materials 50-80%.	(5) Moderate change in sizes. Stable materials 20-50%.	(12) Marked distribution change. Stable materials 0-20%.
Scouring and Deposition	Less than 5% of the bottom affected by scouring and deposition.	(6) 5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	(12) 30-50% affected. Deposits & scour at obstructions, constrictions, and bends. Some filling of pools.	(18) More than 50% of the bottom in a state of flux or change nearly yearlong.
Clinging Aquatic Vegetation (Moss & Algae)	Abundant. Growth largely moss like, dark green, perennial. In swift water too.	(1) Common. Algal forms in low velocity & pool areas. Moss here too and under water.	(7) Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.	(3) Perennial types scarce or absent. Yellow-green, short term bloom may be present.
COLUMN TOTALS -- 11				3

Add the values in each column for a total reach score here.  $(2.11 + 6.31 + 7.3 + 7.8 - 53)$ .

Reach score of: (30-Excellent, 39-76-Good, 77-114-Fair, 115-Poor).

RI-2500-5 (6)



## R-1 STREAM CHANNEL STABILITY FIELD EVALUATION FORM

Wickiup Creek  
8/12/76

Item Rated	Stability Indicators by Classes					
	EXCELLENT			GOOD		
I. UPPER BANKS						
Landform Slope	Bank slope gradient <30%	(2)	Bank slope gradient 30-40%	(3)	Bank slope gradient 40-60%	(6)
Mass Wasting (Existing or Potential)	No evidence of past or potential for future mass wasting into channels.	(3)	Mostly healed over. Low future potential.	(6)	Moderate frequency & size, with some raw spots eroded by water during high flows.	(9)
Debris Jam Potential (Floatable Objects)	Essentially absent from immediate channel area.	(2)	Present but mostly small twigs and limbs.	(4)	Present, volume and size are both increasing.	(5)
Bank Protection from Vegetation	90% + plant density. Vigor and variety suggests a deep, dense root mass.	(3)	70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.	(6)	50-70% density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.	(9)
II. LOWER BANKS						
Channel Capacity	Adequate. Overbank flows increase. Peak flows contained, W/D ratio <7.	(1)	Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8-15.	(2)	Barely contains present peaks. Occasional overbank floods, W/D ratio 15-25.	(3)
Bank Rock Content	65% + with large, angular boulders 12" + numerous.	(2)	40 to 65%, mostly small boulders to cobble 6-12".	(4)	20 to 40%, with most in the 1-6" diameter class.	(6)
Obstructions Flow Deflectors Sediment Traps	Rocks, old logs firmly embedded. Flow pattern of pool & riffles stable without cutting or deposition.	(2)	Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm.	(4)	Moderately frequent, moderately unstable obstructions & deflectors move with high water causing bank cutting and filling of pools.	(6)
Cutting	Little or none evident. Infrequent raw banks less than 6" high generally.	(4)	Some, intermittently at outcrops & constrictions. Raw banks may be up to 12".	(8)	Significant. Cuts 12"-24" high. Root mat overhangs and sloughing evident.	(12)
Deposition	Little or no enlargement of channel or point bars.	(4)	Some new increases in bar formation, most from coarse gravels.	(8)	Moderate deposition of new gravel & coarse sand on old and some new bars.	(12)
III. BOTTOM						
Rock Angularity	Sharp edges and corners, plane surfaces roughened.	(1)	Rounded corners & edges, surfaces smooth & flat.	(2)	Corners & edges well rounded in two dimensions.	(3)
Brightness	Surfaces dull, darkened, or stained. Gen. not "bright".	(1)	Mostly dull but may have up to 35% bright surfaces.	(2)	Mixture, 50-50% dull and bright, ± 15%, to 35-65%.	(3)
Consolidation or Particle Packing	Assorted sizes tightly packed and/or overlapping.	(2)	Moderately packed with some overlapping.	(4)	Mostly a loose assortment with no apparent overlap.	(5)
Bottom Size Distribution	No change in sizes evident. Stable materials 80-100%.	(4)	Distribution shift slight. Stable materials 50-80%.	(8)	Moderate change in sizes. Stable materials 20-50%.	(11)
Scouring and Deposition	Less than 5% of the bottom affected by scouring and deposition.	(6)	Scour at constrictions and where grades steepen. Some deposition in pools.	(12)	30-50% affected. Deposits & scour at obstructions, constrictions, and bends. Some filling of pools.	(18)
Clinging Aquatic Vegetation (Moss & Algae)	Abundant. Growth largely moss like, dark green, perennials. In swift water too.	(1)	Common. Algal forms in low velocity & pool areas. Moss here too and suffer waters.	(2)	Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.	(3)
COLUMN TOTALS						27

Add the values in each column for a total reach score here. (P. 8 + G. 39 + R. 24 + P. 7 - 75).

Reach score of: (38=Excellent, 39-76=Good, 77-114=Fair, 115=Poor).

RI-2300-3 (6)



are compared to those of the Divide and Dillon weather stations (Figure 5). Although 1977 was the wetter year for the two lowland weather stations, a heavier winter snow pack and more spring rain characterized the Upper Camp station for 1978.

#### Stream Discharge

The staff-discharge rating curves for the Lower Camp and Upper Camp sample stations are presented in Figures 6 and 7. The gauging sites remained nearly stable during the two sampling years, except for some minor sedimentation at the upper station and modest bank erosion at the lower station.

The 1977 and 1978 annual hydrographs for the Lower Camp and Upper Camp Creek sample stations are presented in Figures 8-11. Peak flow during 1977 at the Lower Camp station apparently occurred in early to mid-April during an unusually warm period. An estimated crest stage value of 19 cfs was recorded during mid-April, although a higher flow may have occurred prior to the first sampling visit. The lowest recorded flow during 1977 was only 2.4 cfs during mid-July. The 1978 year produced an early peak flow of 25 cfs in mid-April which preceeded the seasonal peak discharge of approximately 90 cfs in late May. The lowest recorded flow for 1978 was 5.4 cfs in mid-August. The Upper Camp station exhibited similar patterns. An estimated peak discharge of 18 cfs was noted in mid-April, 1977, although a higher flow may have occurred previously. The lowest recorded flow for the year was 3.6 cfs in mid-July. In the 1978, an annual peak flow of 70 cfs was measured in mid- to late May, while the lowest flow was recorded at 3.3 cfs in the previous October. The differences noted in flow patterns for the two hydrologic years are largely attributed to differences in the annual



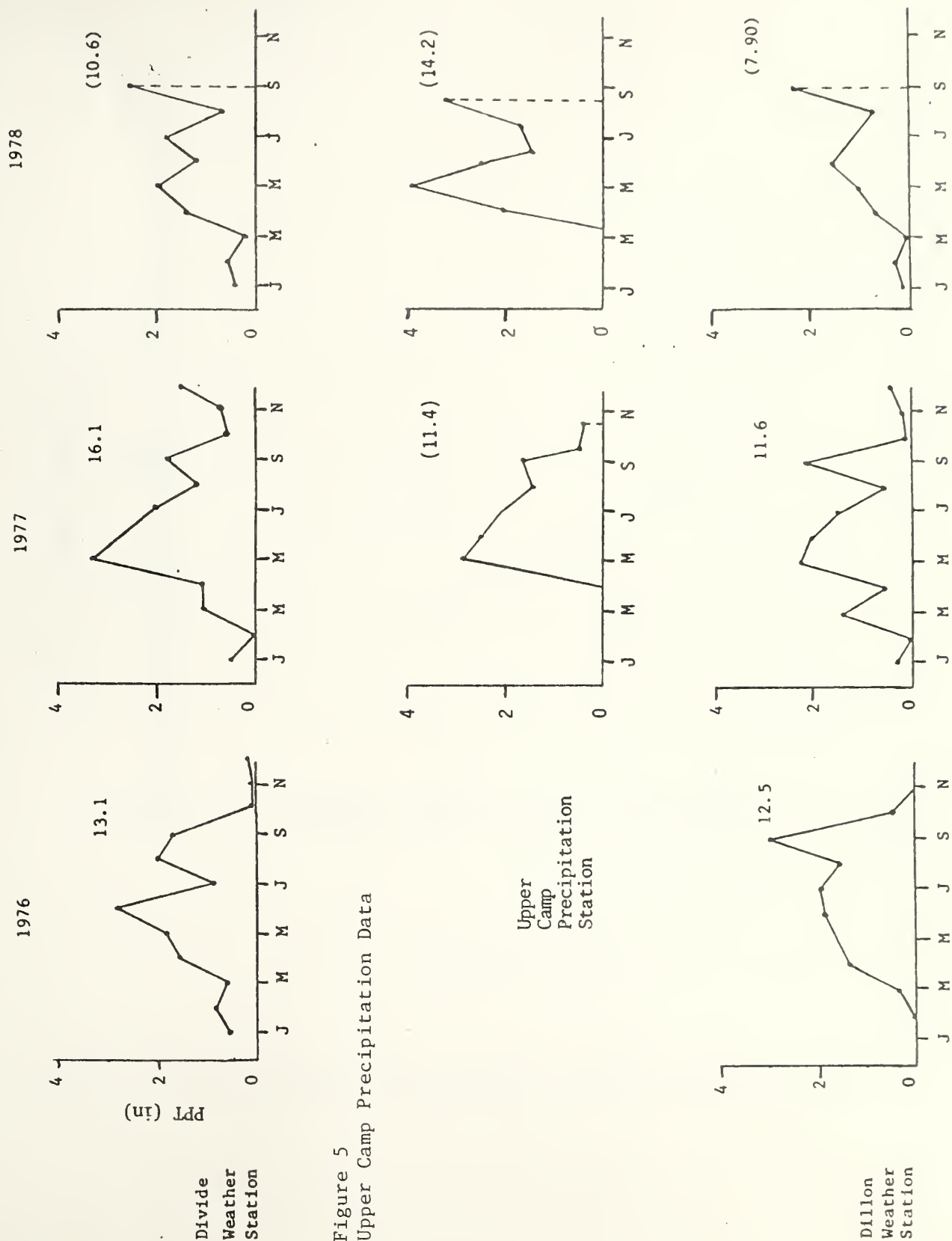


Figure 5  
Upper Camp Precipitation Data



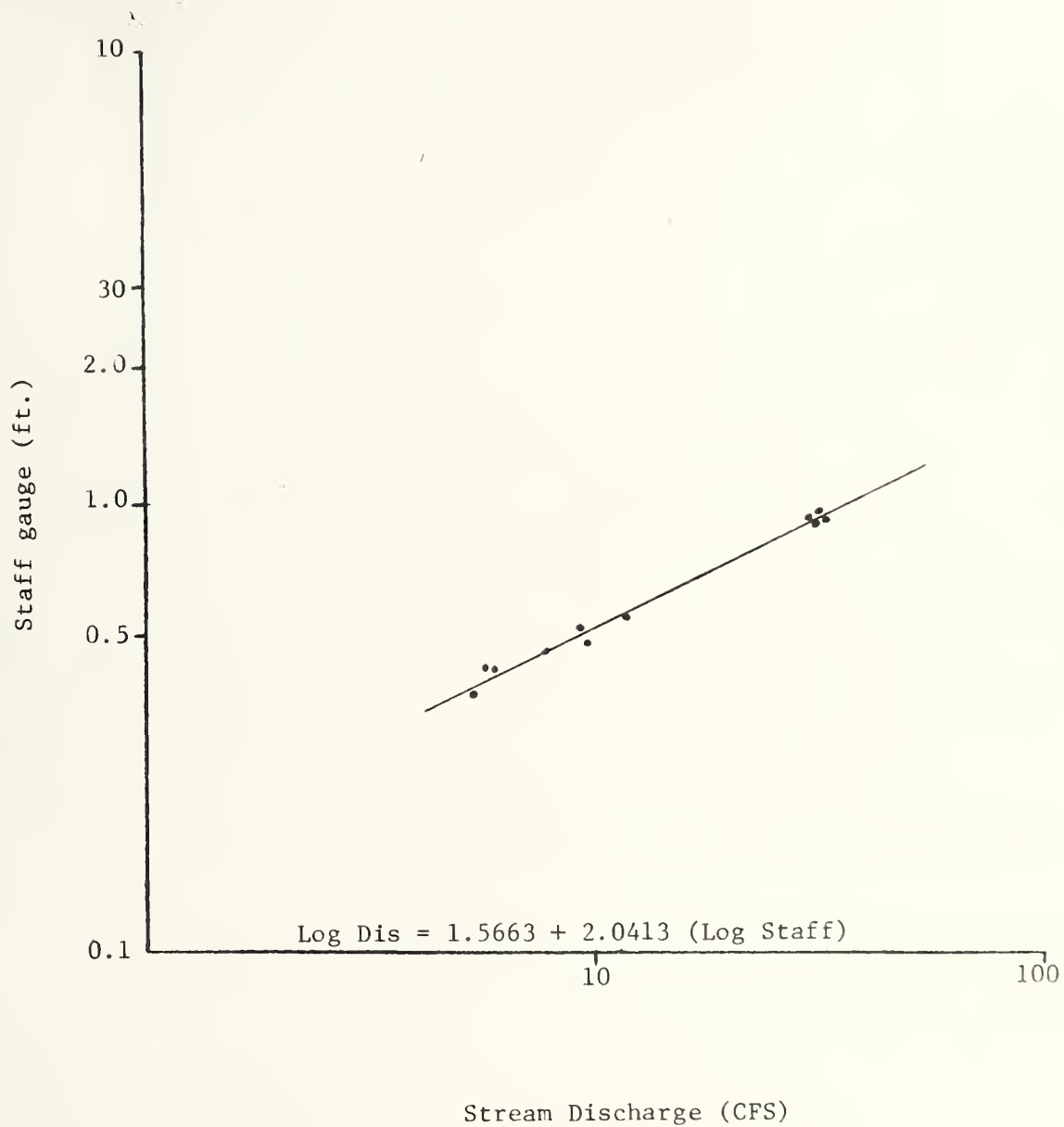


FIGURE 6 Staff-discharge rating curve for Lower Camp sampling station



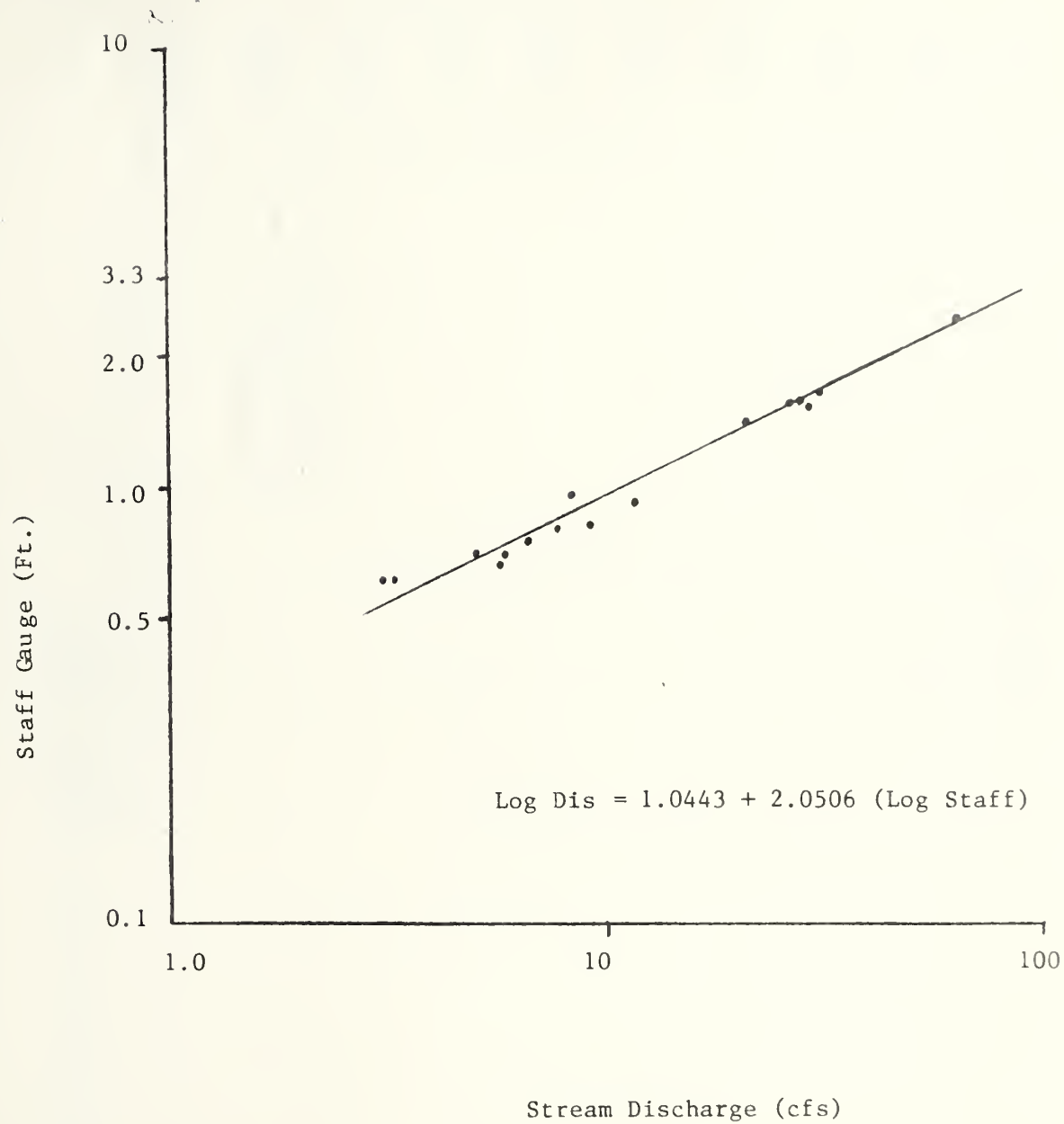


FIGURE 7 Staff-Discharge Rating Curve For Upper Camp Sampling Station



FIGURE 8. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

LOWER CAMP - 1977

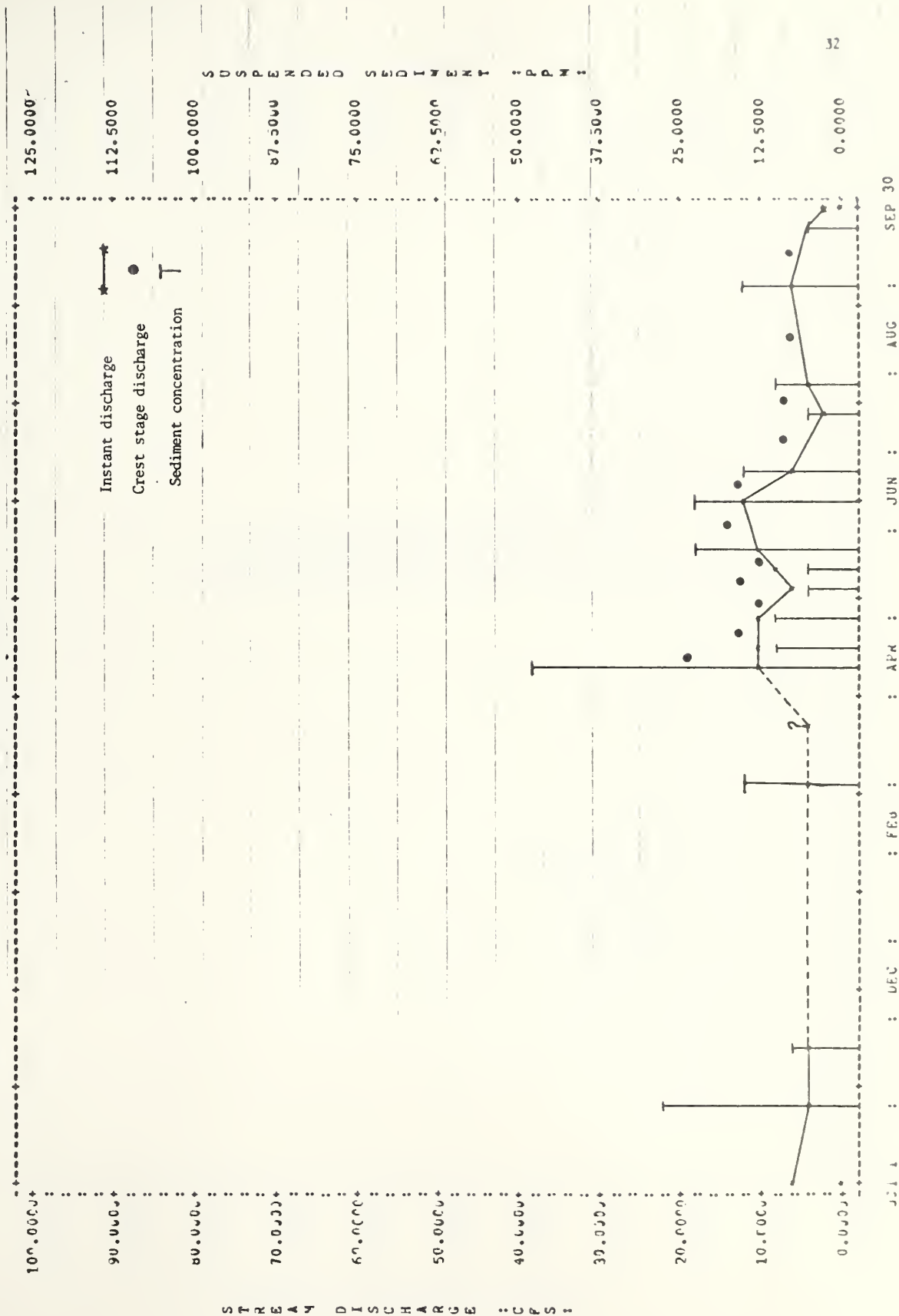




Figure 9. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

LOWER CAMP - 1978

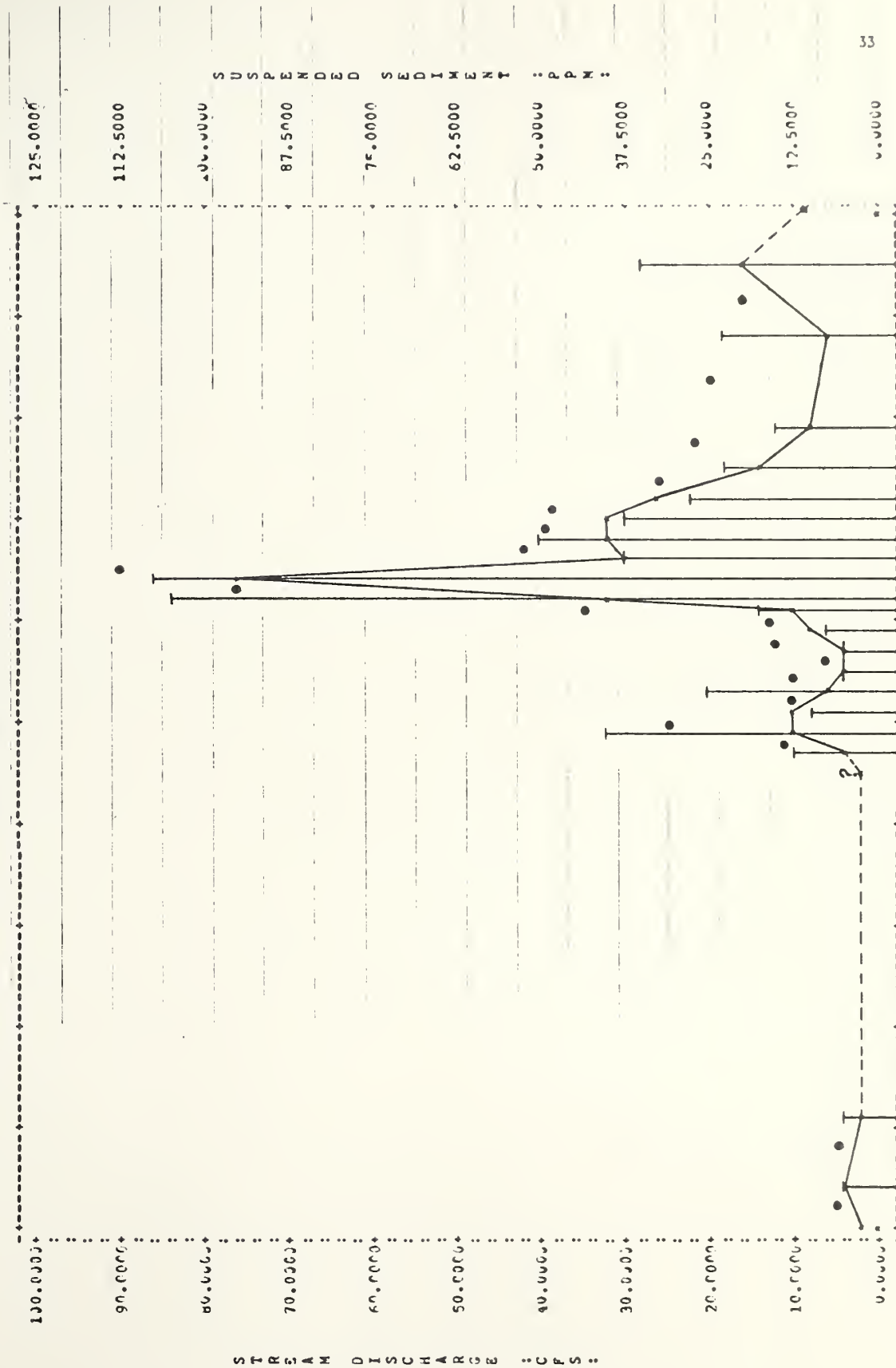
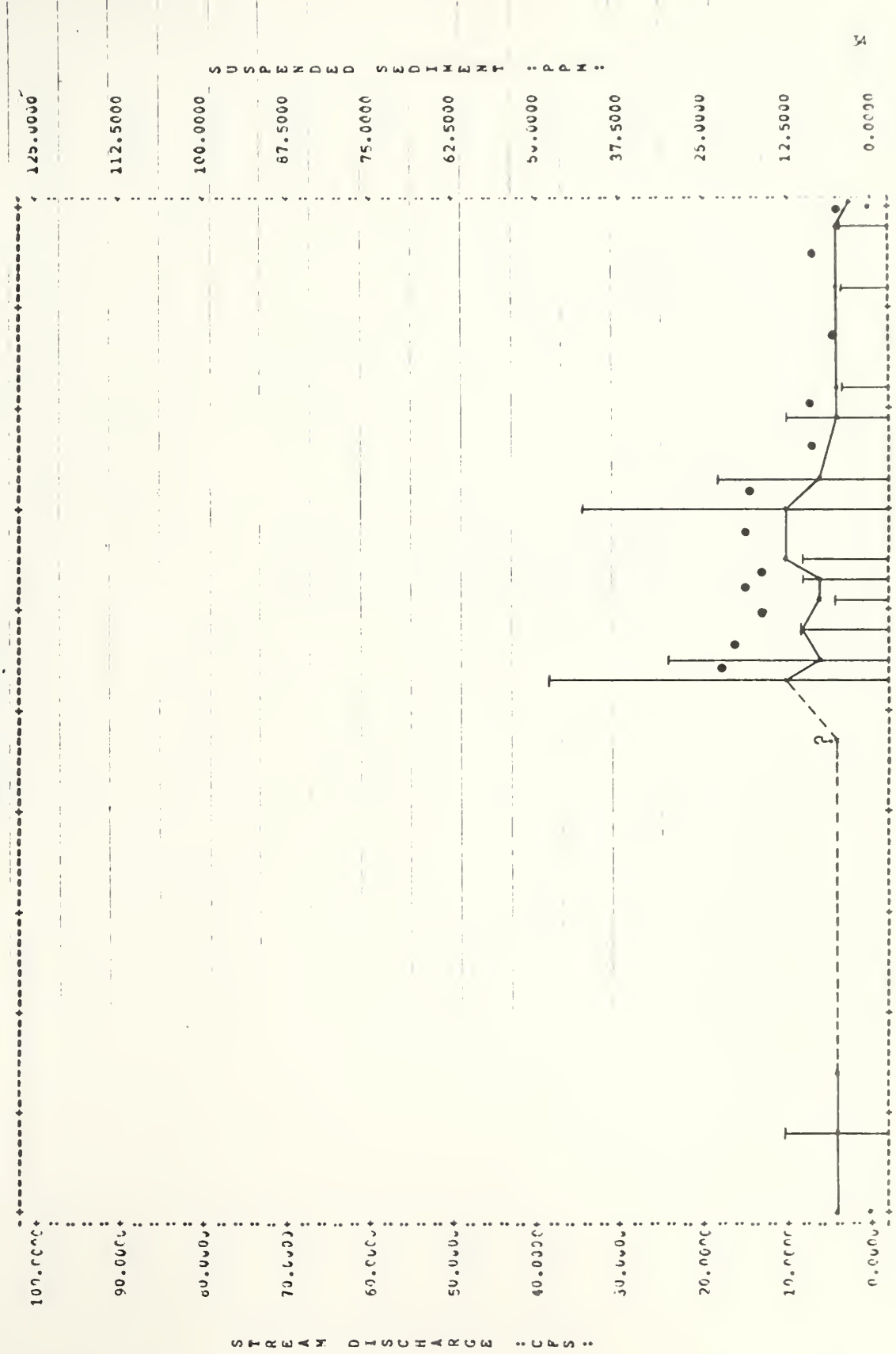




FIGURE 10. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

UPPER CAMP - 1971

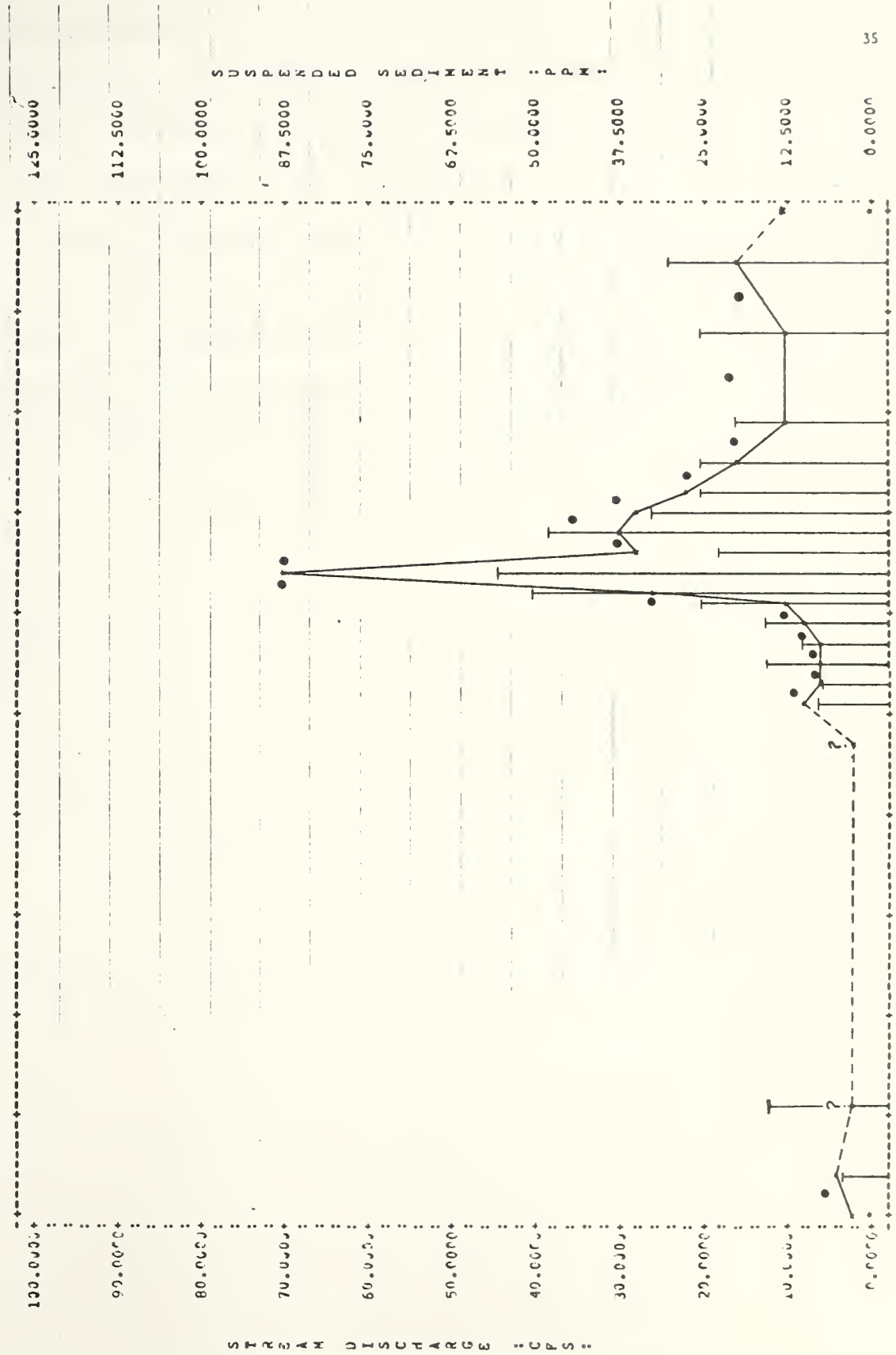


OCT 1 : : DEC : : APR : : JUN : : AUG : : SEP 30



FIGURE 11. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

UPPER CAMP - 1978





precipitation patterns.

The respective annual hydrograph data were used to estimate the annual water yields for each station (Table 4). In both water years, the estimated yield for the Upper Camp station was comparable to that of the Lower Camp station. These values approximated 4,000 acre feet and 7,000 acre feet respectively. This condition is partially attributed to differences in the influence that evapotranspirational stress within the riparian zone has on stream flow at these two stations in this southwesterly facing basin. A 75 percent increase in water yield was noted for 1978 at each station.



Table 4

Water and Sediment Yields  
Camp and Moose Creek Sample Basins

Station Name	Water Year	Estimated Water Yield (ac. - ft.)	Estimated Sediment Yield (tons)	Contributing Watershed (acres)	Runoff (in. - ac.)	Sediment Yield (lbs/acre)
Lower Camp	1977	4,100	95	21,120	2.34	8.95
	1978	7,100	415	"	4.01	39.3
Upper Camp	1977	3,900	75	11,360	4.12	13.1
	1978	7,000	177	"	7.43	48.8
Lower Moose	1977	9,500	304	23,300	4.89	26.1
	1978	11,000	450	"	5.68	38.6
Upper Moose	1977	6,500	73	15,390	5.07	9.49
	1978	7,100	176	"	5.54	22.9
MacLean	1977	590	12	2,560	2.77	9.47
	1978	530	14	"	2.48	11.1



### Suspended Sediment

The annual pattern of sediment concentration for each station by hydrologic year is depicted in figures 8-11. Suspended sediment concentrations at the Lower Camp station ranged from <5 ppm at low flow to 107 ppm at high flow, while those for the upper station ranged from <5 ppm to 54 ppm. Higher suspended sediment values were recorded during the 1978 hydrologic year when there were higher discharge values. The relationships between suspended sediment and stream discharge for each station were statistically significant, and are presented in Figures 12 and 13. The variability in sediment concentration with stream flow is partially attributed to a seasonal effect, specific storm effects, and to the hysteresis effect, whereby peak concentrations of suspended sediment generally occur prior to peak runoff during the rising stage (Gregory and Walling, 1973, pp. 215-219). Annual sediment yields for the two sample stations were estimated from respective water yield and sediment concentration data (Table 4). The lower and upper stations produced approximately 95 tons and 75 tons of suspended sediment respectively during 1977. These yields were increased to 415 tons and 277 tons for the more active 1978 hydrologic year.

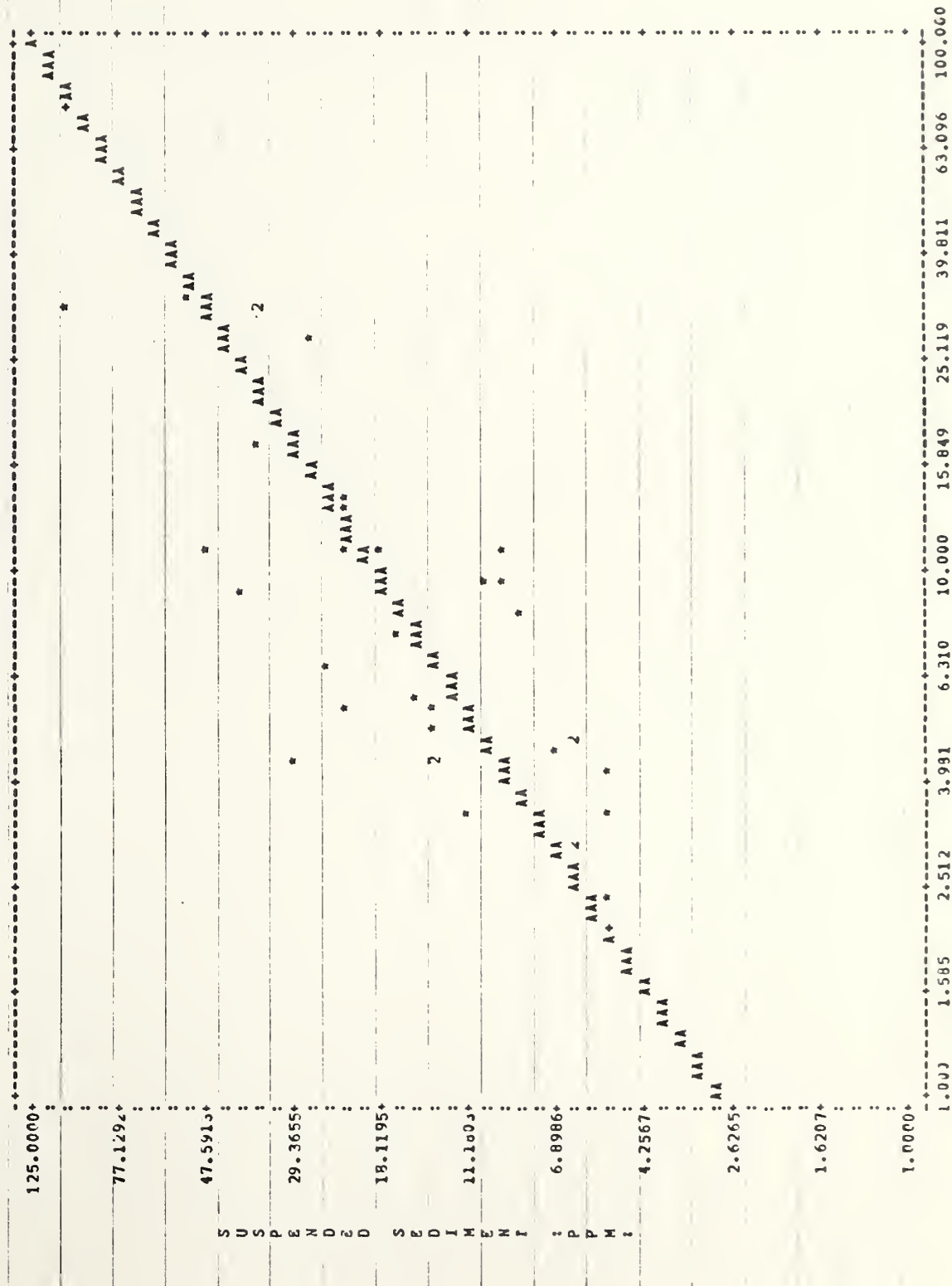
### Hydrochemical Parameters

The concentration of dissolved solids is inversely related to stream discharge so that lower concentrations occur during periods of high runoff, while higher concentrations are found during periods of low summer base flow (Gunnerson, 1967; Gregory and Walling, 1973, pp. 219-225). Patterns for specific ions, especially the ecologically important ones, often vary from this generalization (Likens, et al., 1977, pp. 74-76).



FIGURE 12. SUSPENDED SEDIMENT VS STREAM DISCHARGE - LOWER CAMP

LOG SED = 0.4585 + 0.8158 (LOG DIS)

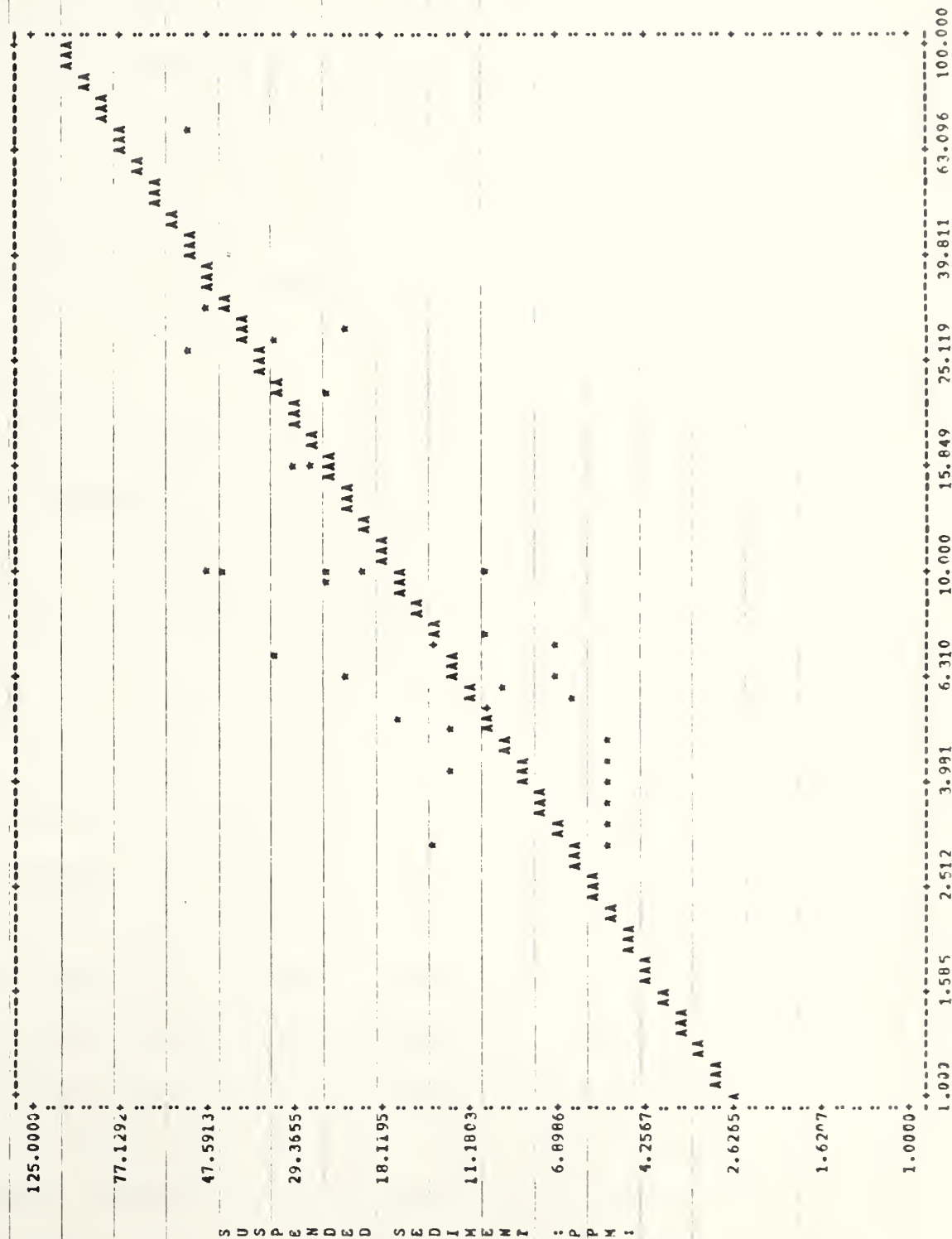


STREAM DISCHARGE :CFS:



FIGURE 13. SUSPENDED SEDIMENT VS STREAM DISCHARGE - UPPER CAMP

LOG SED = 0.4333 \* J.7963 (LOG DIS)





Specific conductance for the Lower Camp station ranged from a low of 108 umhos during high spring runoff to a high of 193 umhos during late summer base flow. The Upper Camp station exhibited a similar pattern, values ranging from 88 umhos to a high of 148 umhos. The relationships between specific conductance and stream discharge for each station were statistically significant and are presented in Figures 14 and 15. Variation in specific conductance with stream discharge is partially attributed to seasonal and storm hysteresis effects (Gregory and Walling, 1973, pp. 219-225). The ranges in ionic concentration for specific ions are presented in Table 5.

#### Bacteria Levels

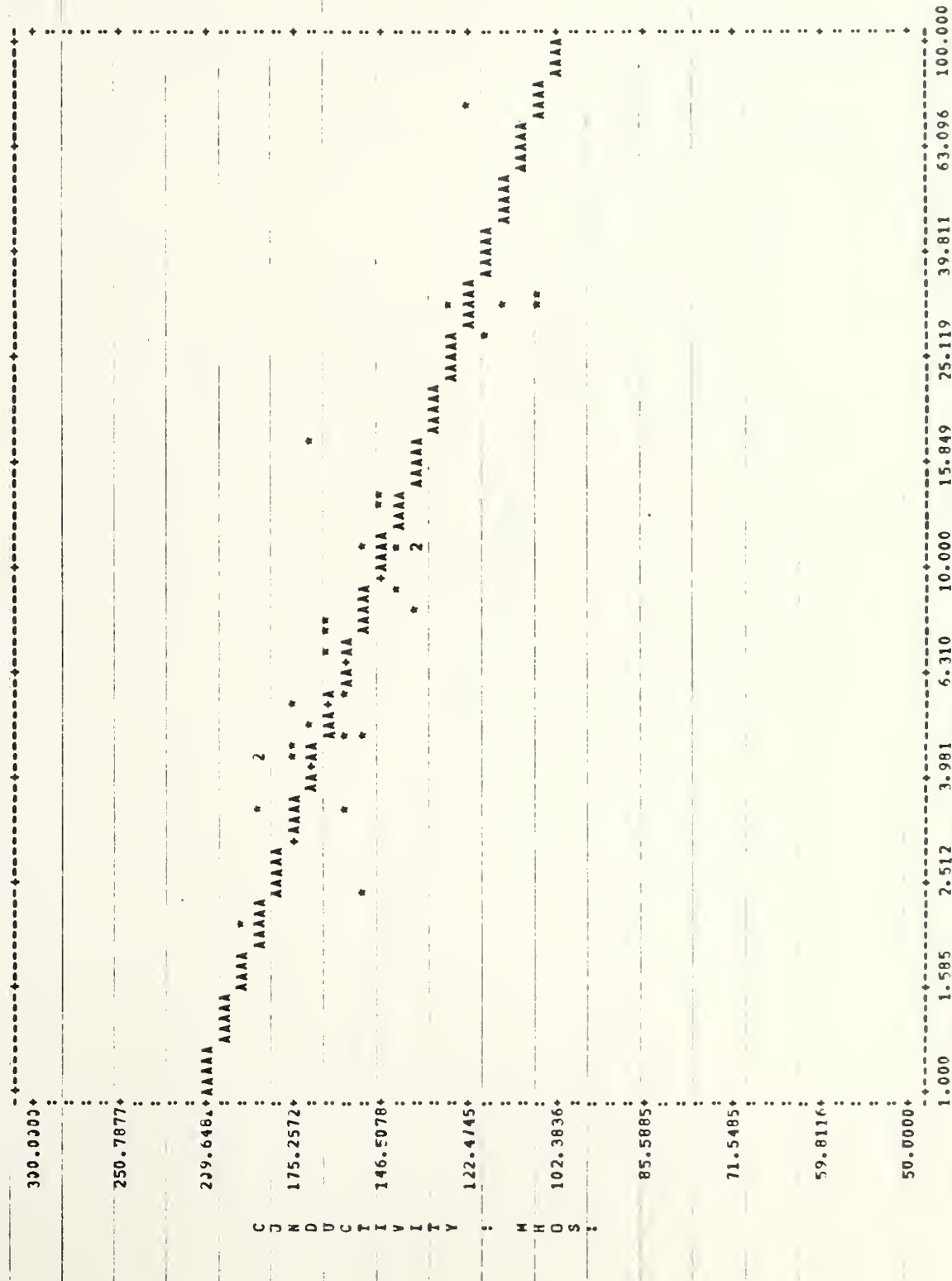
The concentration of fecal and total coliform in streams draining rangeland watersheds is directly related to the number of cattle present, their access to the stream, the physical and hydrological characteristics of the basin, local weather conditions (Kunkle, 1970; Stephensen and Street, 1978), and the time of day (Kunkle and Meiman, 1968). Seasonal patterns include a spring "flushing" effect during the rising state (Kunkle and Meiman, 1968), and with high counts during the low flow summer period, counts which often continue for some period after the cattle have been removed from the area (Stephensen and Street, 1978). This seasonal pattern may briefly be modified by local storms which produce their own "flushing" effect, and which may or may not be followed by a short term dilution period.

The concentrations of fecal coliform for the Lower and Upper Camp stations for the study period are presented in Table 6. Higher values occurred during the grazing season, especially with the known presence of livestock. Maximum fecal coliform levels were 340 and 523 colonies/100mls respectively for each station. Approximately 8 percent and 17 percent of



FIGURE 14. CONDUCTIVITY VS STREAM DISCHARGE - LOWER CAMP

LOG COND = 2.3272-0.1595(LOG DIS)

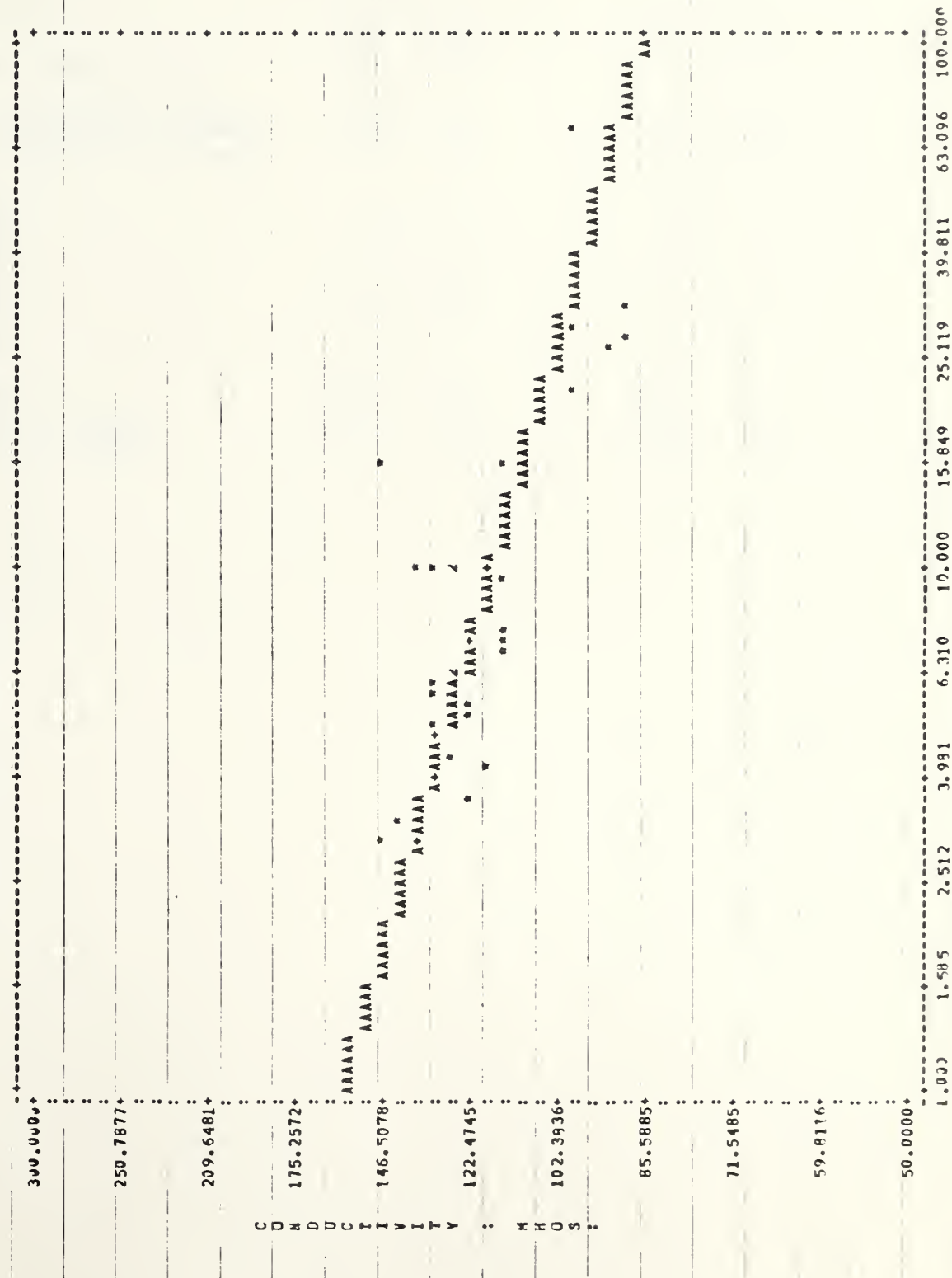


STREAM DISCHARGE :CFS:



FIGURE 15. CONDUCTIVITY VS STREAM DISCHARGE - UPPER CAMP

LUG COND = 2.2029-0.134(LOG DIS)



STREAM DISCHARGE :CFS:



Table 5      Ranges of Hydrochemical Characteristics for the Camp  
Creek Sample Stations for 1977 - 1978

	Lower Camp	Upper Camp
pH	6.85 - 8.00	6.73 - 7.82
Alkalinity ( $\text{CaCO}_3$ ) (mg/l)	28 - 107	28 - 57
Specific Conductance ( $\mu\text{mhos}$ )	108 - 193	88 - 148
Total Dissolved Solids (mg/l)	70 - 125	57 - 96
Ca (mg/l)	13 - 28	9.8 - 28
Mg (mg/l)	3.9 - 10	2.9 - 6.3
Na (mg/l)	4.4 - 8.3	3.5 - 6.9
K (mg/l)	1.3 - 3.2	1.3 - 2.7
$\text{HCO}_3$ (mg/l)	42 - 131	33 - 69
$\text{SO}_4$ (mg/l)	12 - 36	12 - 26
$\text{NH}_4$ (mg/l)	<.01 - .08	<.01 - .05
$\text{NO}_2 + \text{NO}_3 - \text{N}$ (mg/l)	<.01 - .09	<.01 - .10
$\text{PO}_4$ (Ortho) -P (mg/l)	.012 - .053	.006 - .048



Table 6      Fecal Coliform Concentrations (Colonies/100 mls) for the  
Camp Creek Sample Stations for 1977 and 1978.

	Lower Camp		Upper Camp	
	1977	1978	1977	1978
April	--	--	--	--
May	98(?)	< 2	3(?)	< 2
June	34(?)	10*	249*	19
July	124*	19(?)	29*	147(?)
August	42*	19(?)	58*	83(?)
September	16*	340*	7*	523*
October	3*		25*	
November	7*		23(?)	

\*Stock visually present

(?) Stock presence uncertain



the sample coliform counts exceeded the 200 colony/100 ml limit of the Montana Water Quality Criteria. Low values were associated with the spring season. A spring "flush" may be in evidence in Lower Camp during May, 1977.

#### Comments

The Camp Creek basin is prone to wide ranges in its flow regime owing to its configuration, aspect, and position relation to local storm paths. Because of the limited number of samples taken and the nature of the hydrochemical parameters evaluated, relationships between the water quality characteristics of Camp Creek and the Montana Water Quality criteria cannot be addressed.



### Moose Creek Basin

The Moose Creek sample basin was visited a total of 16 and 19 times during the two hydrologic years. The Lower Moose and MacLean stations presented no appreciable accessibility problems. The Upper Moose station was inaccessible from late October, 1977 until early May, 1978. This station was monitored 13 and 12 times respectively.

#### Channel Stability Ratings

The lower Moose Creek stream section from Chicken Gulch to MacLean Creek, and the MacLean Creek stream section were evaluated on September 23, 1976. The upper Moose Creek segment from the eastern boundary of the Humbug Spires Palmitive Area to Moosetown was evaluated on August 12, 1976. The lower Moose Creek segment was rated as 'good' (44) (Table 7), MacLean Creek as 'good' (48) (Table 8), and the upper Moose Creek portion as 'good' (66) (Table 9).

#### Precipitation

Precipitation was measured at the Upper Moose precipitation station from April 30, 1977 through October 15, 1977 and from April 25 through September 12, 1978. The general precipitation patterns during these two fiscal years are compared to those of the Divide and Dillon weather stations (Figure 16). On several occasions the tops of the gauges had been removed, therefore the data presented is the minimum amount recorded. Precipitation patterns for the two hydrologic years appear comparable, indicating peaks in May and September.



Table 7

R-1 STREAM CHANNEL STABILITY FIELD EVALUATION FORM

Lower Moose Creek  
9/23/76

Item Rated	Stability Indicators by Classes			
	EXCELLENT	GOOD	FAIR	POOR
<b>I. UPPER BANKS</b>				
Bank Slope	(2) Bank slope gradient <30% (3) No evidence of past or potential for future mass wasting into channels.	(2) Bank slope gradient 30-40% (3) Infrequent and/or very small future potential.	(3) Bank slope gradient 40-60% (4) Moderate frequency & size, with some raw spots eroded by water during high flows.	(6) Bank slope gradient 60%+ (9) Frequent or large, causing sediment nearly yearlong OR imminent danger of same.
Debris Jam Potential (Floatable Objects)	(2) Essentially absent from immediate channel area.	(2) Present but mostly small twigs and limbs.	(3) Present, volume and size are both increasing.	(6) Moderate to heavy amounts, predominantly larger sizes.
Bank Protection	(3) 90%+ plant density. Vigor and variety suggests a deep, dense root mass.	(3) 70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.	(6) 50-70% density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.	(9) <50% density plus fewer species & less vigor indicate poor, discontinuous, and shallow root mass.
Vegetation	(2)	(2)	(6)	(9)
<b>II. LOWER BANKS</b>				
Channel Capacity	(1) Ample for present plus some increases. Peak flows contained, W/D ratio <7.	(1) Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8-15.	(2) Barely contains present peaks. Occasional overbank floods, W/D ratio 15-25.	(3) Inadequate. Overbank flows common. W/D ratio >25.
Bank Rock Content	(2) 65%+ with large, angular boulders 12" + numerous.	(2) 40 to 65%, mostly small boulders to cobble 6-12".	(4) 20 to 40%, with most in the 3-6" diameter class.	(6) <20% rock fragments of gravel sizes, 1-3" or less.
Obstructions	(2) Rocks, old logs firmly embedded. Flow pattern of pool & riffles stable without cutting or deposition.	(2) Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm.	(4) Moderately frequent, moderately unstable obstructions & deflectors move with high water causing bank cutting and filling of pools.	(6) Frequent obstructions and deflectors cause bank erosion yearlong. Sed. traps full, channel migration occurring.
Flow Deflectors	(2)	(2)	(4)	(6)
Sediment Traps	(2)	(2)	(4)	(6)
Cutting	(4) Little or none evident. Infrequent raw banks less than 6" high generally.	(4) Some, intermittently at outcrops & constrictions. Raw banks may be up to 12".	(8) Significant. Cuts 12"-24" high. Root mat overhangs and sloughing evident.	(12) Almost continuous cuts, some over 24" high. Failure of overhangs frequent.
Deposition	(4) Little or no enlargement of channel or point bars.	(4) Some new increases in bar formation, most from coarse gravels.	(8) Moderate deposition of new gravel & coarse sand on old and some new bars.	(12) Extensive deposits of predominately fine particles. Accelerated bar development.
<b>III. BOTTOM</b>				
Rock Angularity	(1) Sharp edges and corners, plane surfaces roughened.	(1) Rounded corners & edges, surfaces smooth & flat.	(2) Corners & edges well rounded in two dimensions.	(3) Well rounded in all dimensions, surfaces smooth.
Brightness	(1) Surfaces dull, darkened, or stained. Gen. not "bright".	(1) Mostly dull but may have up to 35% bright surfaces.	(2) Mixture, 50-50% dull and bright, ± 15%, ie 35-65%.	(3) Predominately bright, 65%+, exposed or scoured surfaces.
Consolidation or Particle Packing	(2) Assorted sizes tightly packed and/or overlapping.	(2) Moderately packed with some overlapping.	(4) Mostly a loose assortment with no apparent overlap.	(6) No packing evident. Loose assortment, easily moved.
Bottom Size Distribution	(4) No change in sizes evident. Stable materials 80-100%.	(4) Distribution shift slight. Stable materials 50-80%.	(8) Moderate change in sizes. Stable materials 20-50%.	(12) Marked distribution change. Stable materials 0-25%.
Scouring and Deposition	(4) Less than 5% of the bottom affected by scouring and deposition.	(4) 5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	(12) 30-50% affected. Deposits & scour at obstructions, constrictions, and bends. Some filling of pools.	(18) More than 50% of the bottom in a state of flux or change nearly yearlong.
Clinging Aquatic Vegetation (Moss & Algae)	(1) Abundant. Growth largely moss like, dark green, perennial. In swift water too.	(1) Common. Algal forms in low velocity & pool areas. Moss here too and suffer waters.	(2) Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.	(3) Perennial types scarce or absent. Yellow-green, short term bloom may be present.
COLUMN TOTALS → 18				→ 26

Add the values in each column for a total reach score here. (E. 18 + G. 26 + F. - + P. - = 44).

Reach score of: (38-Excellent, 39-76-Good, 77-114-Poor, 115-Poor).



Table 8

## R-1 STREAM CHANNEL STABILITY FIELD EVALUATION FORM

MacLean Creek  
9/23/76

Item Rated	Stability Indicators by Classes			
	EXCELLENT	GOOD	FAIR	POOR
<b>I. UPPER BANKS</b>				
Landform Slope	Bank slope gradient <30%. No evidence of past or potential for future mass wasting into channels.	Bank slope gradient 30-40%. Infrequent and/or very small, mostly healed over. Low future potential.	Bank slope gradient 40-60%. Moderate frequency & size, with some raw spots eroded by water during high flows.	Bank slope gradient 60%+. Frequent or large, causing sediment nearly yearlong OR imminent danger of same.
Debris Jam Potential (Floatable Objects)	Essentially absent from immediate channel area.	Present but mostly small twigs and limbs.	Present, volume and size are both increasing.	Moderate to heavy amounts, predominantly larger sizes.
Bank Protection from Vegetation	90%+ plant density. Vigor and variety suggests a deep, dense root mass.	70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.	50-70% density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.	<50% density plus fewer species & less vigor indicate poor, discontinuous, and shallow root mass.
<b>II. LOWER BANKS</b>				
Channel Capacity	Ample for present plus some increases. Peak flows contained. W/D ratio <7.	Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8-15.	Barely contains present peaks. Occasional overbank floods. W/D ratio 15-25.	Inadequate. Overbank flows common. W/D ratio >25.
Bank Rock Content	65%+ with large, angular boulders 12" + numerous.	40 to 65%, mostly small boulders to cobble 6-12".	20 to 40%, with most in the 3-6" diameter class.	<20% rock fragments of gravel sizes, 1-3" or less.
Obstructions	Rocks, old logs firmly embedded. Flow pattern of pool & riffles stable without cutting or deposition.	Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors never and less firm.	Moderately frequent, moderately unstable obstructions & deflectors move with high water causing bank cutting and filling of pools.	Frequent obstructions and deflectors cause bank erosion yearlong. Sed. traps full, channel migration occurring.
Cutting	Little or none evident. Infrequent raw banks less than 6" high generally.	Some, intermittently at outcrops & constrictions. Raw banks may be up to 12".	Significant. Cuts 12"-24" high. Root mat overhangs and sloughing evident.	Almost continuous cuts, some over 24" high. Failure of overhangs frequent.
Deposition	Little or no enlargement of channel or point bars.	Some new increases in bar formation, most from coarse gravels.	Moderate deposition of new gravel & coarse sand on old and some new bars.	Extensive deposits of predominantly fine particles. Accelerated bar development.
<b>III. BOTTOM</b>				
Rock Angularity	Sharp edges and corners, plane surfaces roughened.	Rounded corners & edges, surfaces smooth & flat.	Corners & edges well rounded in two dimensions.	Well rounded in all dimensions, surfaces smooth.
Brightness	Surfaces dull, darkened, or stained. Gen. not "bright".	Mostly dull but may have up to 35% bright surfaces.	Mixture, 50-50% dull and bright, ±15%, ie 35-65%.	Predominately bright, 65%+, exposed or scoured surfaces.
Consolidation or Particle Packing	Assorted sizes tightly packed and/or overlapping. No change in sizes evident.	Moderately packed with some overlapping.	Mostly a loose assortment with no apparent overlap.	No packing evident. Loose assortment, easily moved.
Bottom Size Distribution	Stable materials 80-100%.	Distribution shift slight. Stable materials 50-80%.	Noderate change in sizes. Stable materials 20-50%.	Marked distribution change. Stable materials 0-20%.
Scouring and Deposition	Less than 5% of the bottom affected by scouring and deposition.	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	30-50% affected. Deposits & scour at obstructions, constrictions, and bends.	More than 50% of the bottom in a state of flux or change nearly yearlong.
Clinging Aquatic Vegetation (Moss & Algae)	Abundant. Growth largely moss like, dark green, perennial. In swift water too.	Common. Algal forms in low velocity & pool areas. Moss here too and suffer waters.	Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.	Perennial types scarce or absent. Yellow-green, short term bloom may be present.
COLUMN TOTALS				49

Add the values in each column for a total reach score here. (E. 16 + G. 32 + P. - + P. - = 48).

Reach score of: &lt;38=Excellent, 39-76=Good, 77-114=Fair, 115=Poor.

R1-2500-5 (6)



Table 9

## R-1 STREAM CHANNEL STABILITY FIELD EVALUATION FORM

Upper Moose Creek  
9/23/76

Item Rated	Stability Indicators by Classes				POOR
	EXCELLENT		GOOD		
<b>I. UPPER BANKS</b>					
Bank Slope	Bank slope gradient <30°	Bank slope gradient 30-40°	Bank slope gradient 40-60°	Bank slope gradient 60° +	8
Mass Wasting (Existing or Potential)	No evidence of past or potential for future mass wasting into channels.	Infrequent and/or very small future potential.	Moderate frequency & size, by water during high flows.	Frequent or large, causing imminent danger of same.	1/2
Debris Jam Potential (Floatable Objects)	Essentially absent from immediate channel area.	Present but mostly small twigs and limbs.	are both increasing.	Moderate to heavy amounts, predominantly larger sizes.	8
Bank Protection	90% + plant density. Vigor and variety suggests a deep, dense root mass.	70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.	50-70% density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.	<50% density plus fewer species & less vigor indicate poor, discontinuous, and shallow root mass.	1/2
<b>II. LOWER BANKS</b>					
Channel Capacity	Ample for present plus some increases. Peak flows contained. W/D ratio <7.	Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8-15.	Barely contains present peaks. Occasional overbank floods. W/D ratio 15-25.	Inadequate. Overbank flows common. W/D ratio >25.	4
Bank Rock Content	65% + with large, angular boulders 12" + numerous.	40 to 65%, mostly small boulders to cobble 6-12".	20 to 40%, with most in the 3-6" diameter class.	<20% rock fragments of gravel sizes, 1-3" or less.	8
Obstructions Flow Deflectors Sediment Traps	Rocks, old logs firmly embedded. Flow pattern of pool & riffles stable without cutting or deposition.	Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm.	Moderately frequent, moderately unstable obstructions & deflectors move with high water causing bank cutting and filling of pools.	Frequent obstructions and deflectors cause bank erosion yearlong. Sed. traps full, channel migration occurring.	8
Cutting	Little or none evident. Infrequent raw banks less than 6" high generally.	Some, intermittently at outcrops & constrictions. Raw banks may be up to 12".	Significant. Cuts 12"-24" high. Root mat overhangs and sloughing evident.	Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	16
Deposition	Little or no enlargement of channel or point bars.	Some new increase in bar formation, most from coarse gravels.	Moderate deposition of new gravel & coarse sand on old and some new bars.	Extensive deposits of predominantly fine particles. Accelerated bar development.	16
<b>III. BOTTOM</b>					
Rock Angularity	Sharp edges and corners, plane surfaces roughened.	Rounded corners & edges, surfaces smooth & flat.	Corners & edges well rounded in two dimensions.	Well rounded in all dimensions, surfaces smooth.	4
Brightness	Surfaces dull, darkened, or stained. Gen. not "bright".	Mostly dull but may have up to 35% bright surfaces.	Mixture, 50-50% dull and bright, ± 15%, to 35-65%.	Predominately bright, 65% +, exposed or scoured surfaces.	4
Consolidation or Particle Packing	Assorted sizes tightly packed and/or overlapping. No change in sizes evident.	Moderately packed with some overlapping.	Mostly a loose assortment with no apparent overlap.	No packing evident. Loose assortment, easily moved.	8
Bottom Size Distribution & Percent Stable Materials	Stable materials 80-100%. Less than 5% of the bottom affected by scouring and deposition.	Distribution shift slight. Stable materials 50-80%. 5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	Moderate change in sizes. Stable materials 20-50%. 30-50% affected. Deposits with no apparent overlap.	Marked distribution change. Stable materials 0-20%.	16
Scouring and Deposition	Less than 5% of the bottom affected by scouring and deposition.	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	30-50% affected. Deposits with no apparent overlap.	More than 50% of the bottom in a state of flux or change nearly yearlong.	24
Clinging Aquatic Vegetation (Moss & Algae)	Abundant. Growth largely moss like, dark green, perennial. In swift water too.	Common. Algal forms in low velocity & pool areas. Moss here too and suffer waters.	Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.	Perennial types scarce or absent. Yellow-green, short term bloom may be present.	4
COLUMN TOTALS					7

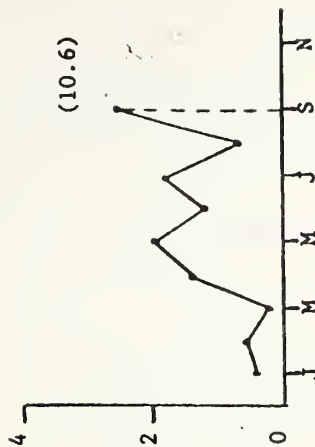
Add the values in each column for a total reach score here. (2.6 + 6.50 + 7.3 + 7.7 = 66).

Reach score of: (38-Excellent, 39-76-Good, 77-114-Poor, 115-Poor).

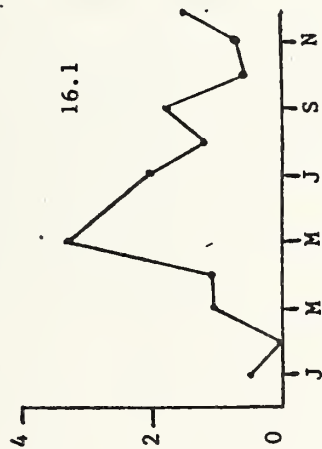
RI-2500-3 (6)



1978



1977



1976

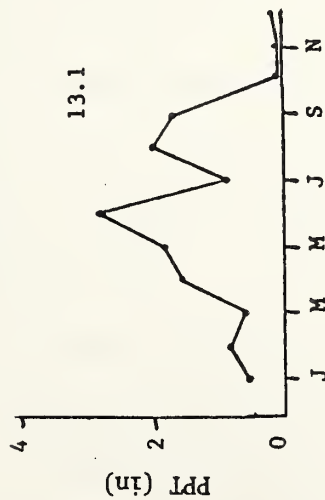
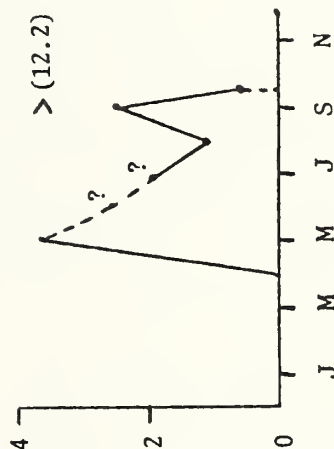
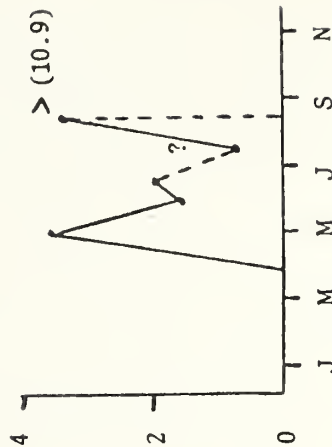
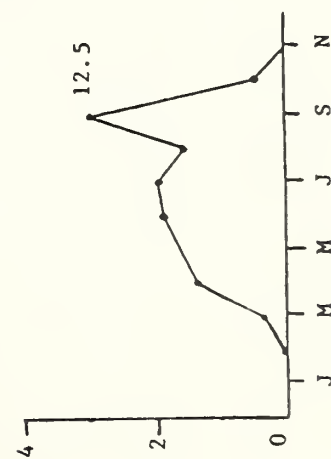
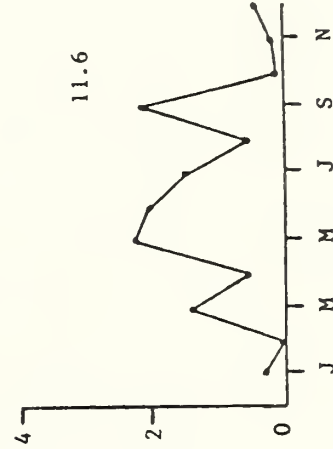
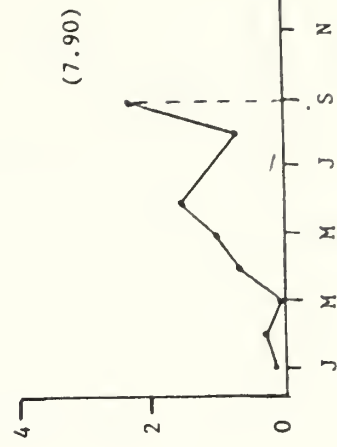


Figure 16

Upper Moose Precipitation Data



Upper Moose Precipitation Station



Dillon Weather Station



## Stream Discharge

The staff - discharge rating curves for the Lower Moose, Upper Moose, and MacLean sample stations are presented in Figures 17 - 19. The gauging sites at the Lower Moose and Upper Moose stations remained relatively stable during the two sample years. Some bank erosion is believed to have occurred immediately downstream from the MacLean station and may have affected the staff discharge relationships for the 1977 season.

The 1977 and 1978 annual hydrographs for the Lower Moose, Upper Moose and MacLean sample stations are presented in Figures 20 - 25. Peak flow at the Lower Moose station during 1977 apparently occurred in early to mid-April during an unusually warm period. An estimated crest stage value of 103 cfs was recorded during mid-April, although a higher flow may have occurred prior to the first sampling visit. A secondary peak flow of 50 cfs followed in early June. The lowest recorded flow during 1977 was only 5.3 cfs during mid-July. The 1978 year produced an early peak flow of 80 cfs in early April which preceeded the seasonal peak discharge of approximately 122 cfs in mid-May. The lowest recorded flow for the 1978 hydrologic year was 8.6 cfs for the previous Fall months. An estimated peak flow of 35 cfs was noted for the Upper Moose station in mid-May, 1977, although a higher value may have passed previously. Low flow for the year was 3 cfs during the late summer. In 1978, a peak flow of 53 cfs was recorded in mid- to late May, while the lowest flow was again 3 cfs for the previous October.

MacLean Creek station exhibited a modest peak of 1.2 cfs in mid-April, 1977; although a higher flow may have occurred earlier that month. Flow remained relatively constant the remainder of the year with a recorded



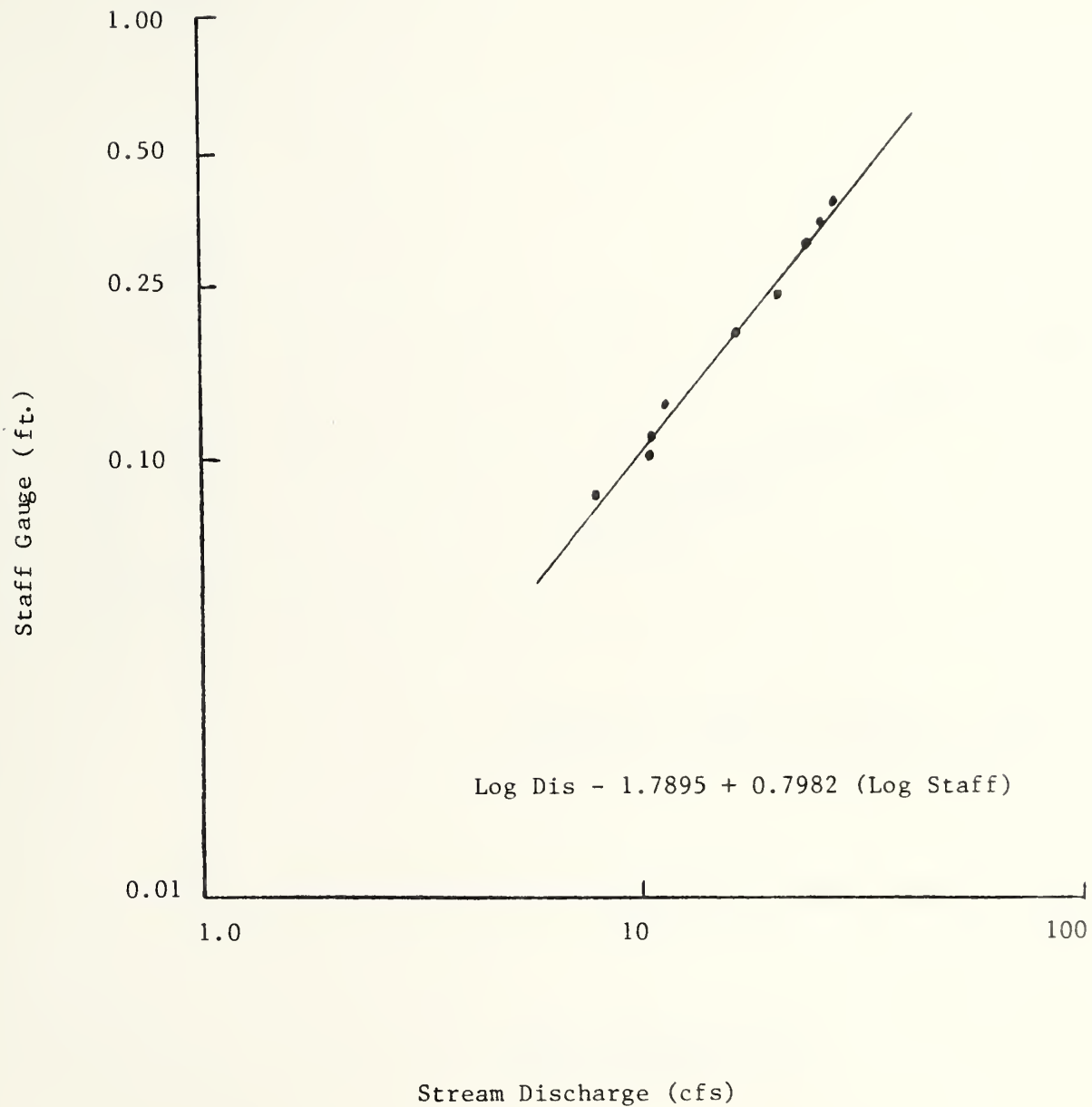


FIGURE 18 Staff-discharge rating curve for Upper Moose sampling station



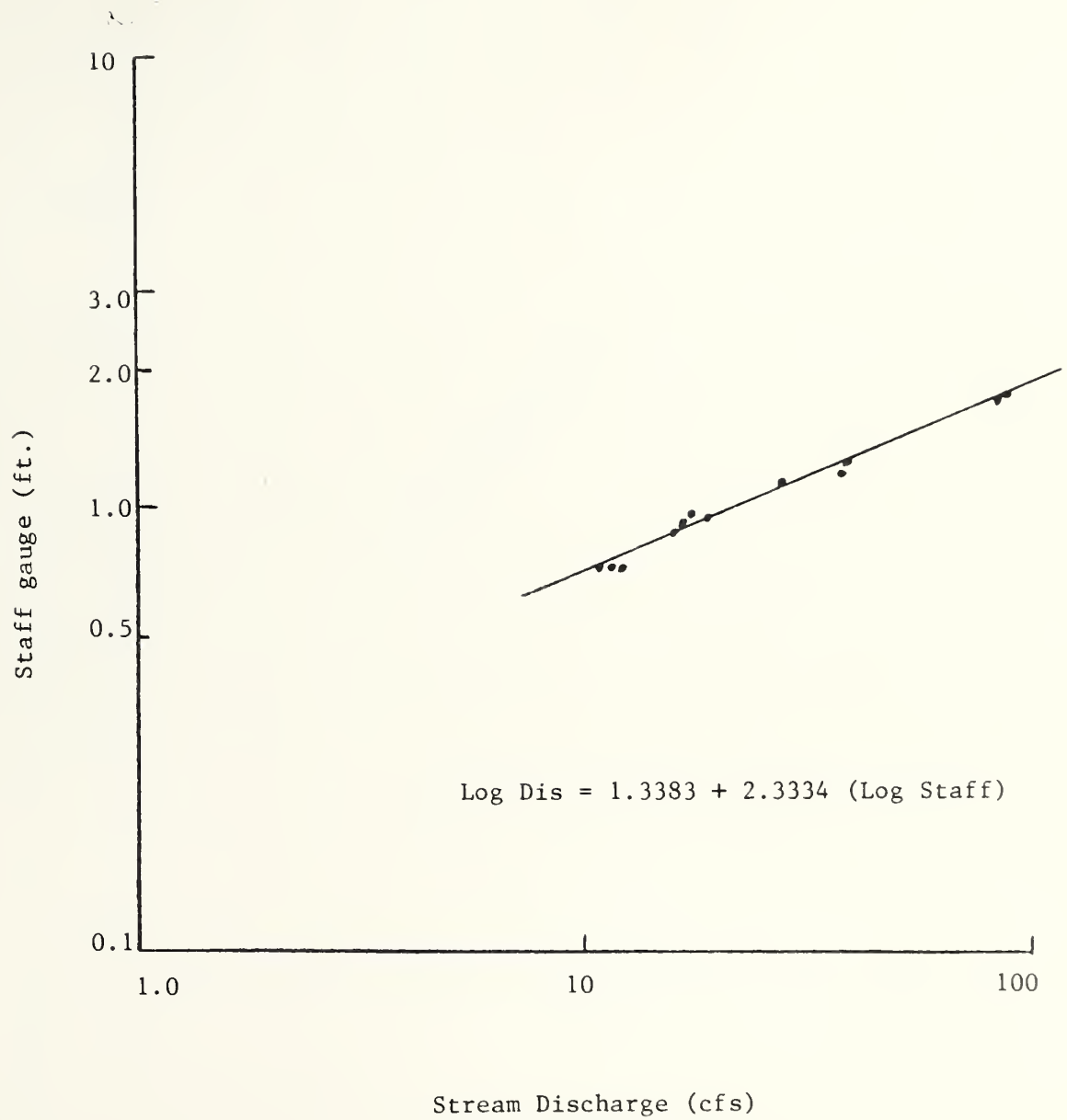


FIGURE 17 Staff-discharge rating curve for Lower Moose sampling station



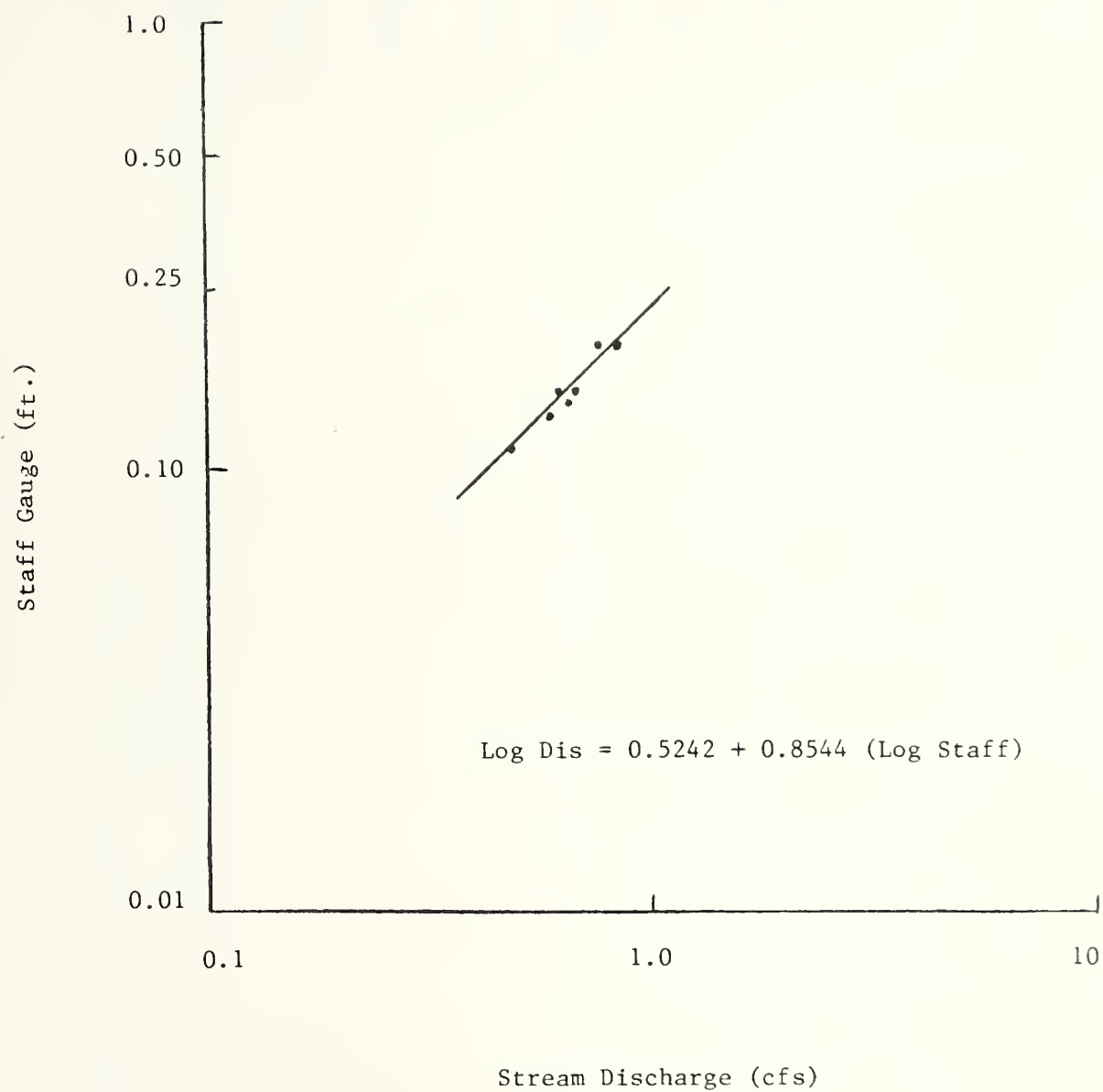


FIGURE 19 Staff-discharge rating curve for MacLean camp sampling station



FIGURE 20. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

LOWER MOOSE - 1977

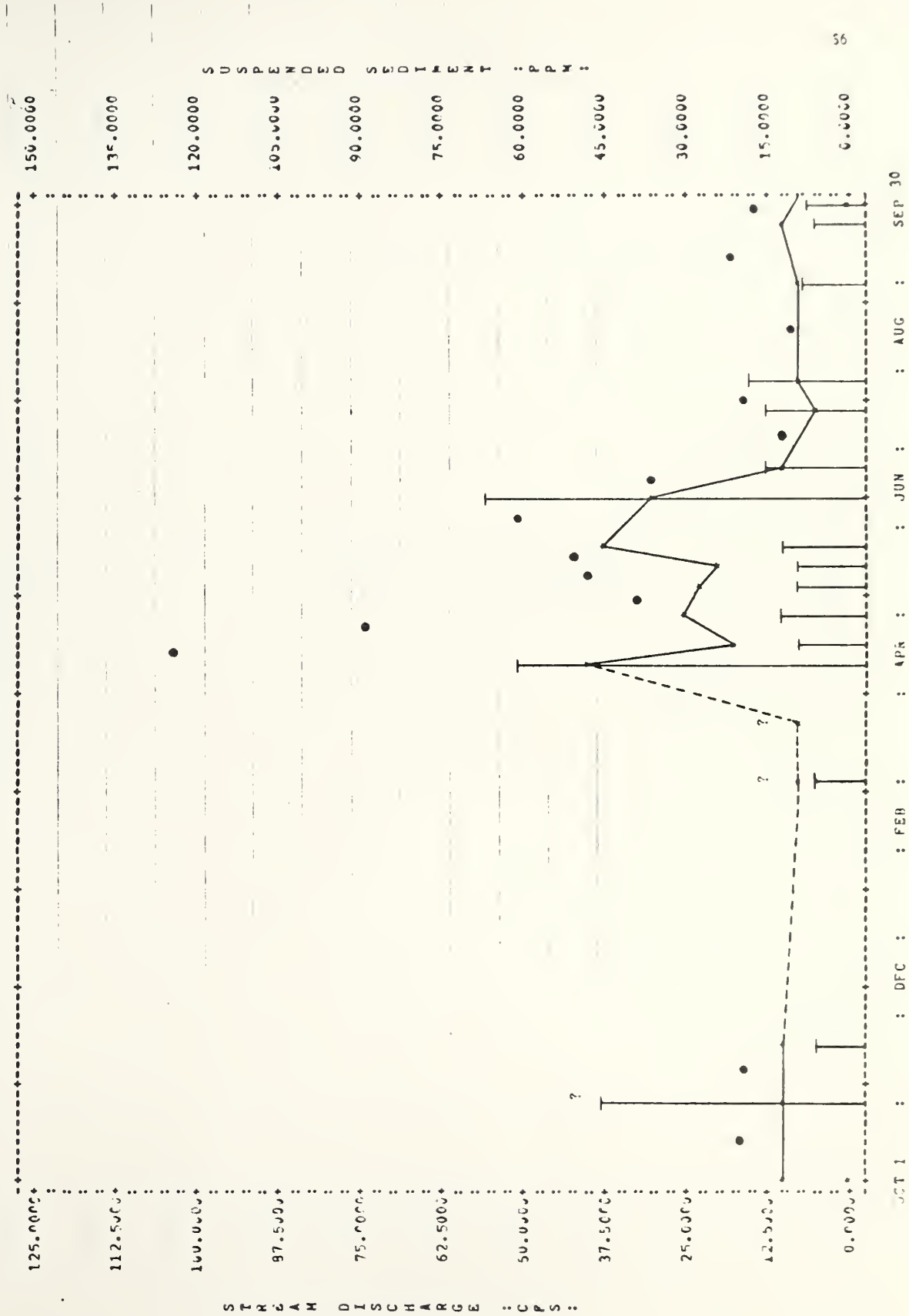




FIGURE 21. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

LOWER MOOSE - 1976

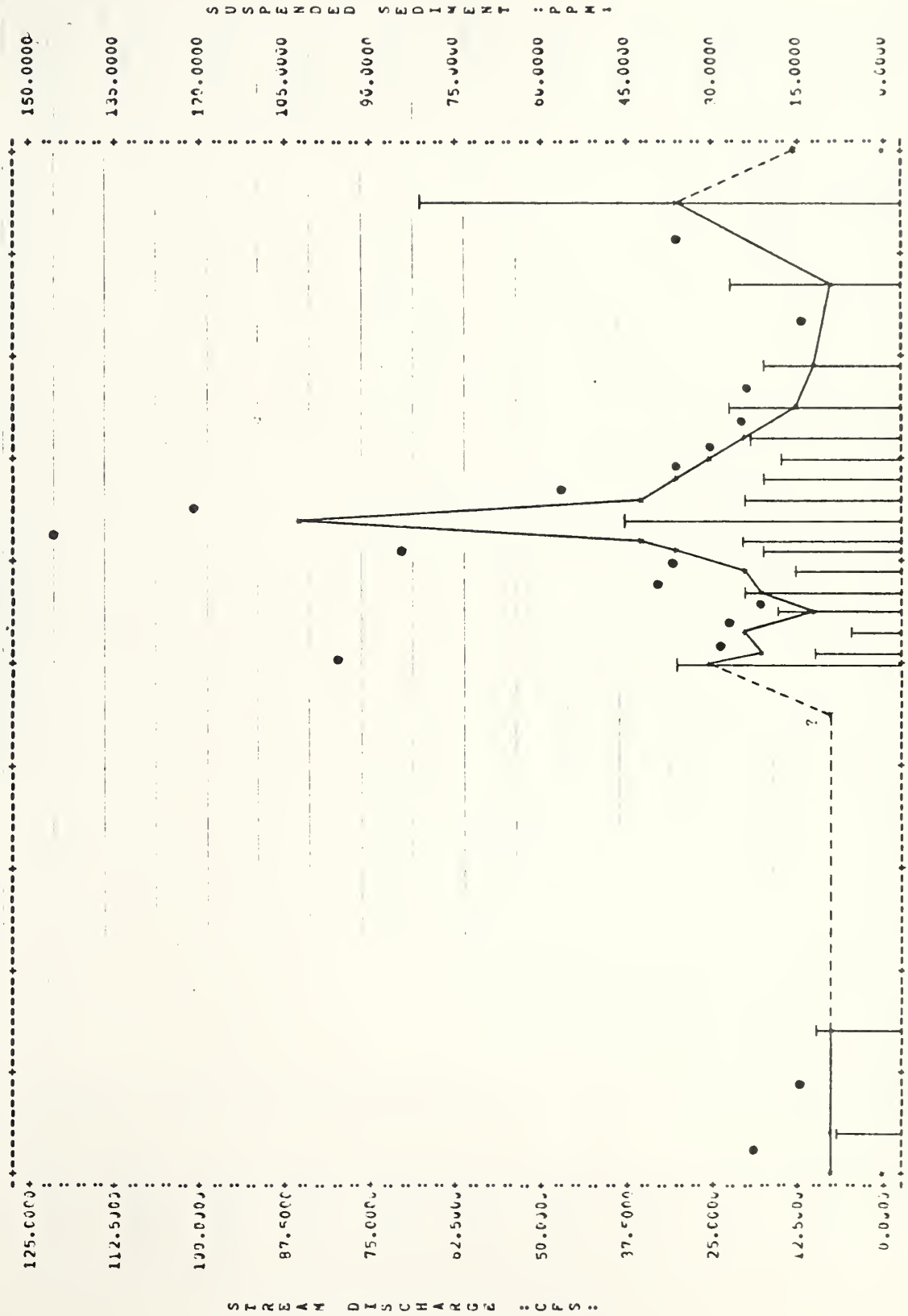




FIGURE 22. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

UPPER MOOSE - 1977

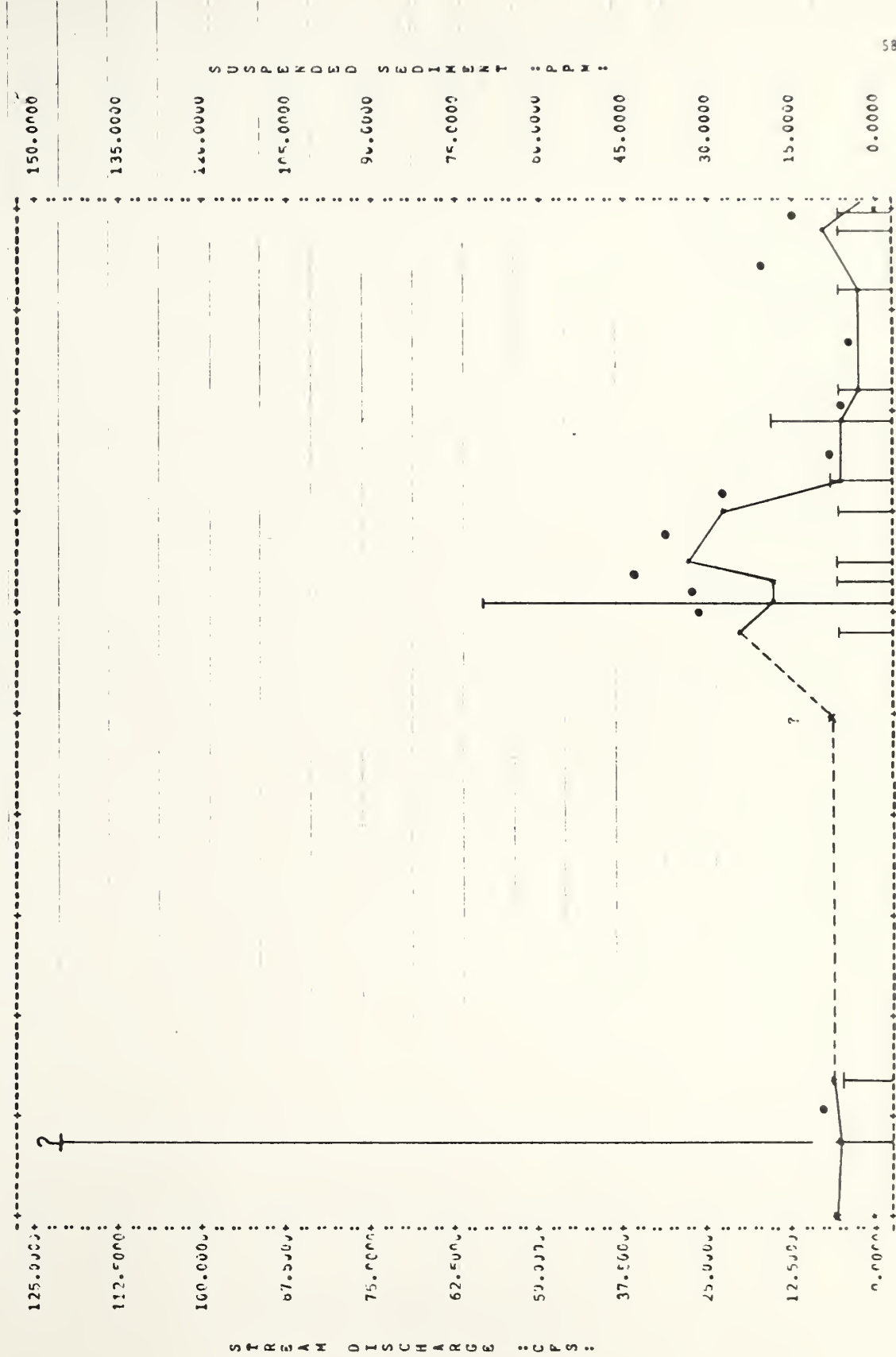




FIGURE 23, ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

UPPER MOOSE - 1978

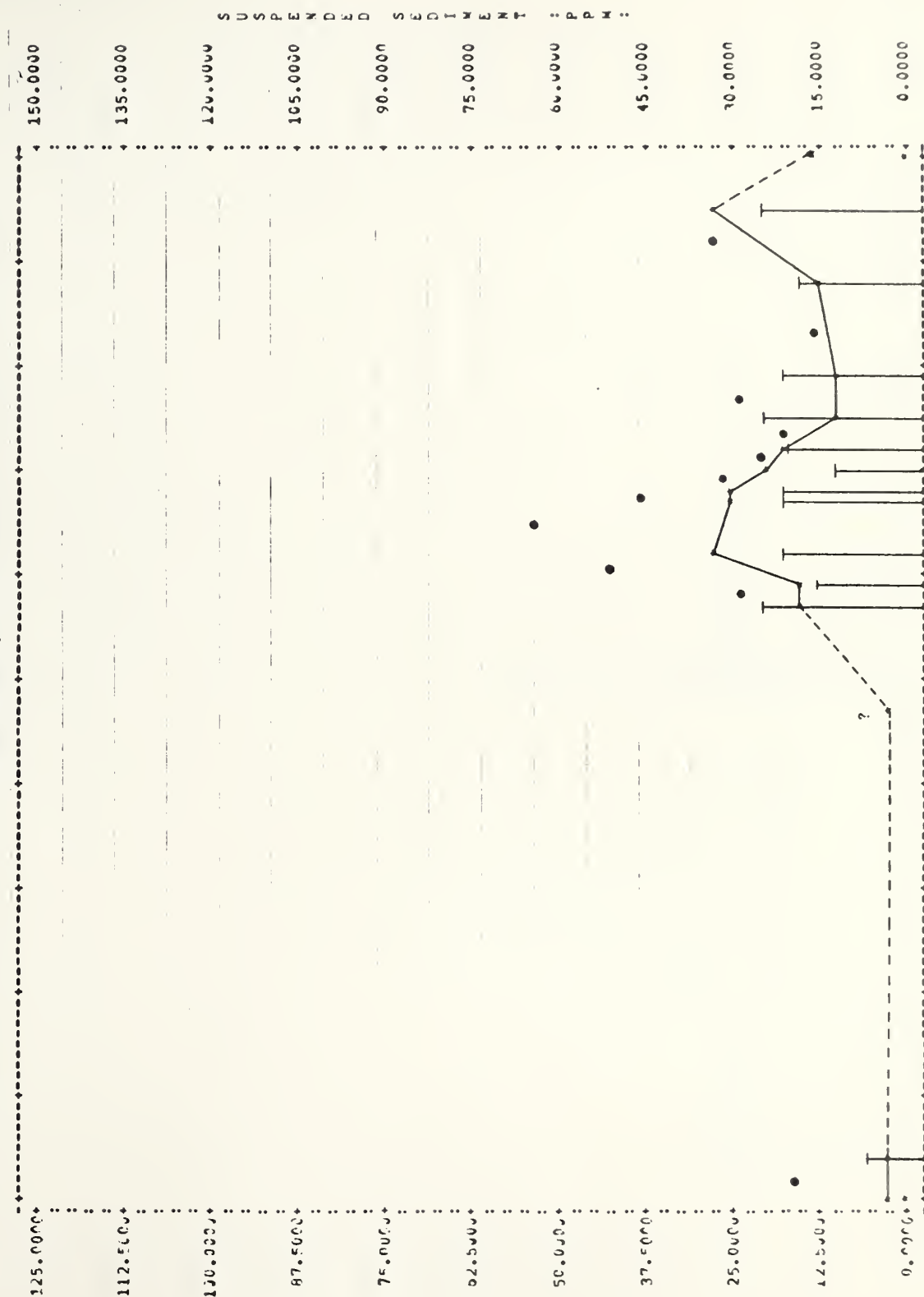




FIGURE 24. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

MACLEAN - 1977

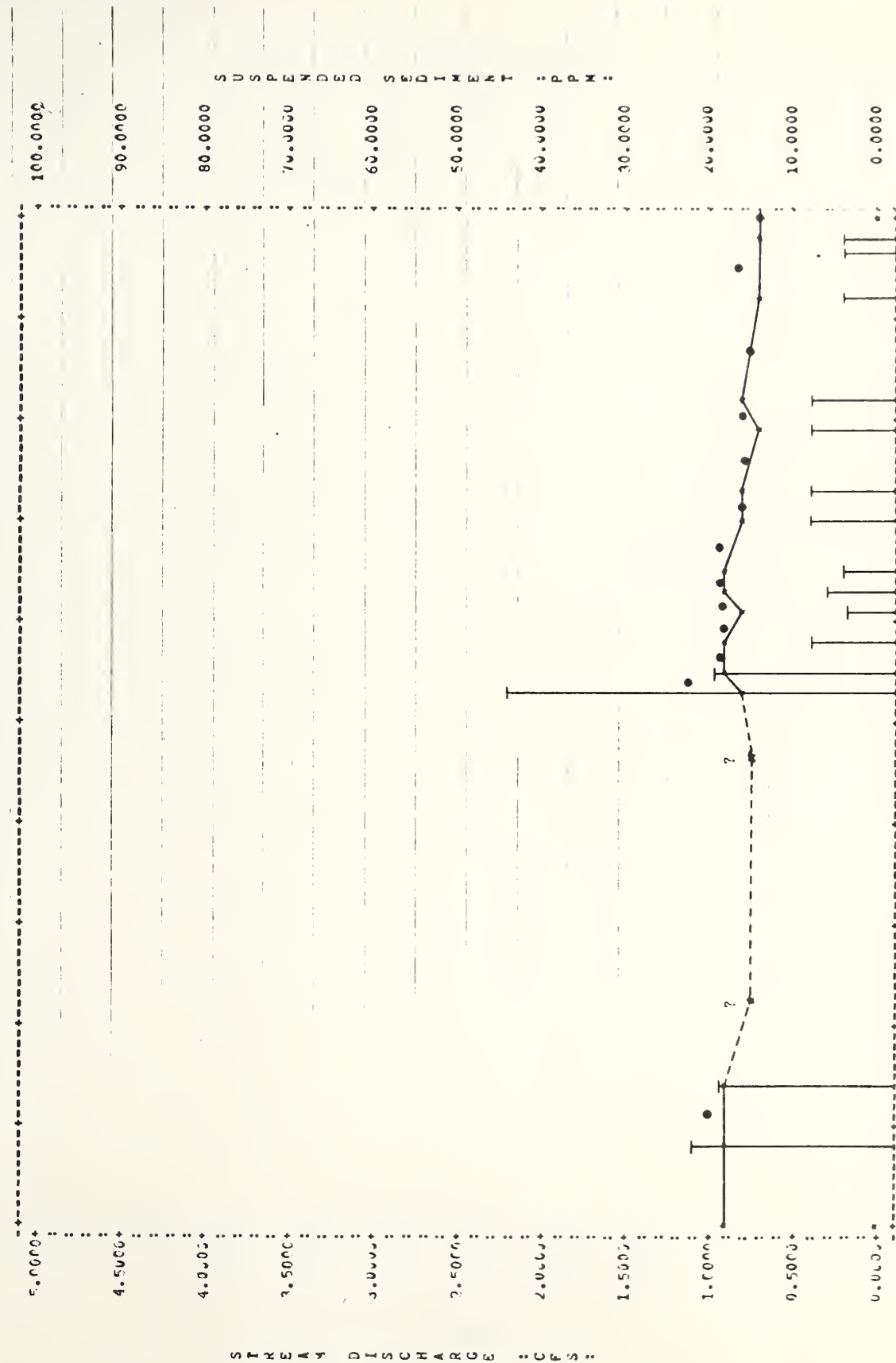
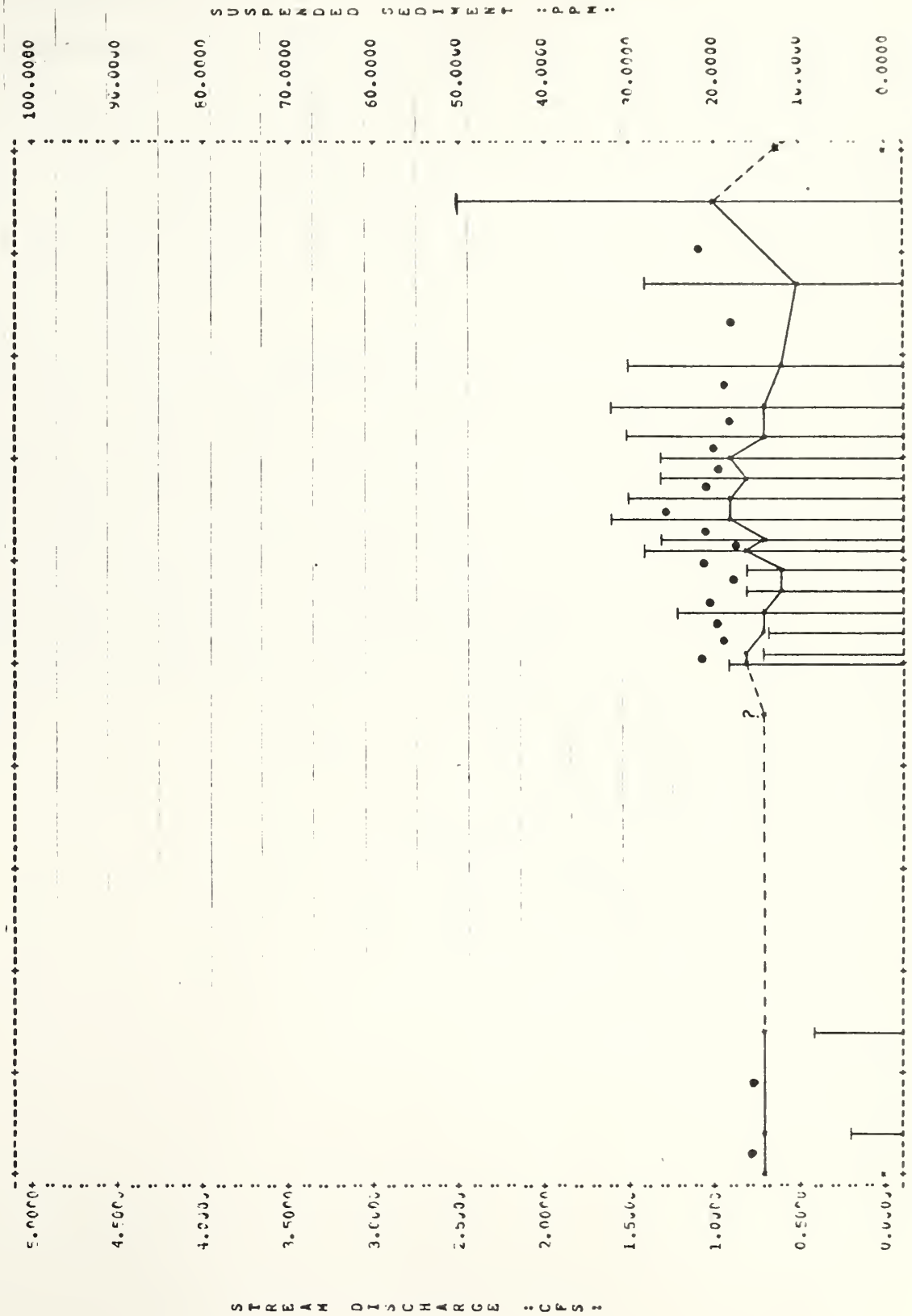




FIGURE 25. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

MACLEAN - 1976





seasonal low of 0.72 cfs in late September. The discharge values for the Fall and Winter of 1976 - 1977 may be slightly overestimated owing to suggested changes in the channel reach immediately below the station. The 1978 year exhibited a modest peak of 1.3 cfs in late May and a seasonal low of 0.51 in August. The differences noted between the two hydrologic years at the sample stations are largely attributed to differences in the annual precipitation patterns.

The respective annual hydrograph data were used to estimate annual water yields for each station (Table 4). Water yields for Lower Moose were approximately 9,500 acre feet and 11,000 acre feet for the two sample years. The upper station averaged about two-thirds of that volume, 6,500 acre feet and 7,100 acre respectively. The 1978 figure for the upper station was calculated using estimates for the long mid-October 1977 through late April, 1978 period when the station was inaccessible.



## Suspended Sediment

The annual pattern of sediment concentration for each station by hydrologic year is depicted in figures 20 - 25. Suspended sediment concentrations at the Lower Moose station ranged from  $\leq 5$  at low flow to 81 ppm at high flow, while those for the upper station ranged from  $\leq 5$  ppm to 147 ppm, the latter a questionable value that was recorded in the Fall of 1976. The next highest sediment concentration was 69 ppm. In MacLean Creek, sediment concentrations ranged from  $\leq 5$  ppm to 51 ppm. The relationships between suspended sediment and stream discharge for the Lower and Upper Moose stations were statistically significant, and are presented in Figures 26 and 27. There is no apparent relationship for the MacLean station (Figure 28). The variability in sediment concentration with stream flow is partially attributed to a seasonal effect, specific storm effects, and to the hysteresis effect whereby peak concentrations of suspended sediment generally occur prior to peak runoff during the rising stage (Gregory and Walling, 1973, pp. 215-219). Annual sediment yields for the two sample stations were estimated from respective water yield and sediment concentration data (Table 4). The lower and upper stations of Moose Creek produced approximately 304 tons and 73 tons of suspended sediment respectively during 1977. These yields were increased to 405 tons and 176 tons for the 1978 hydrologic year. Sediment production in MacLean Creek was estimated at 12 and 14 tons respectively.

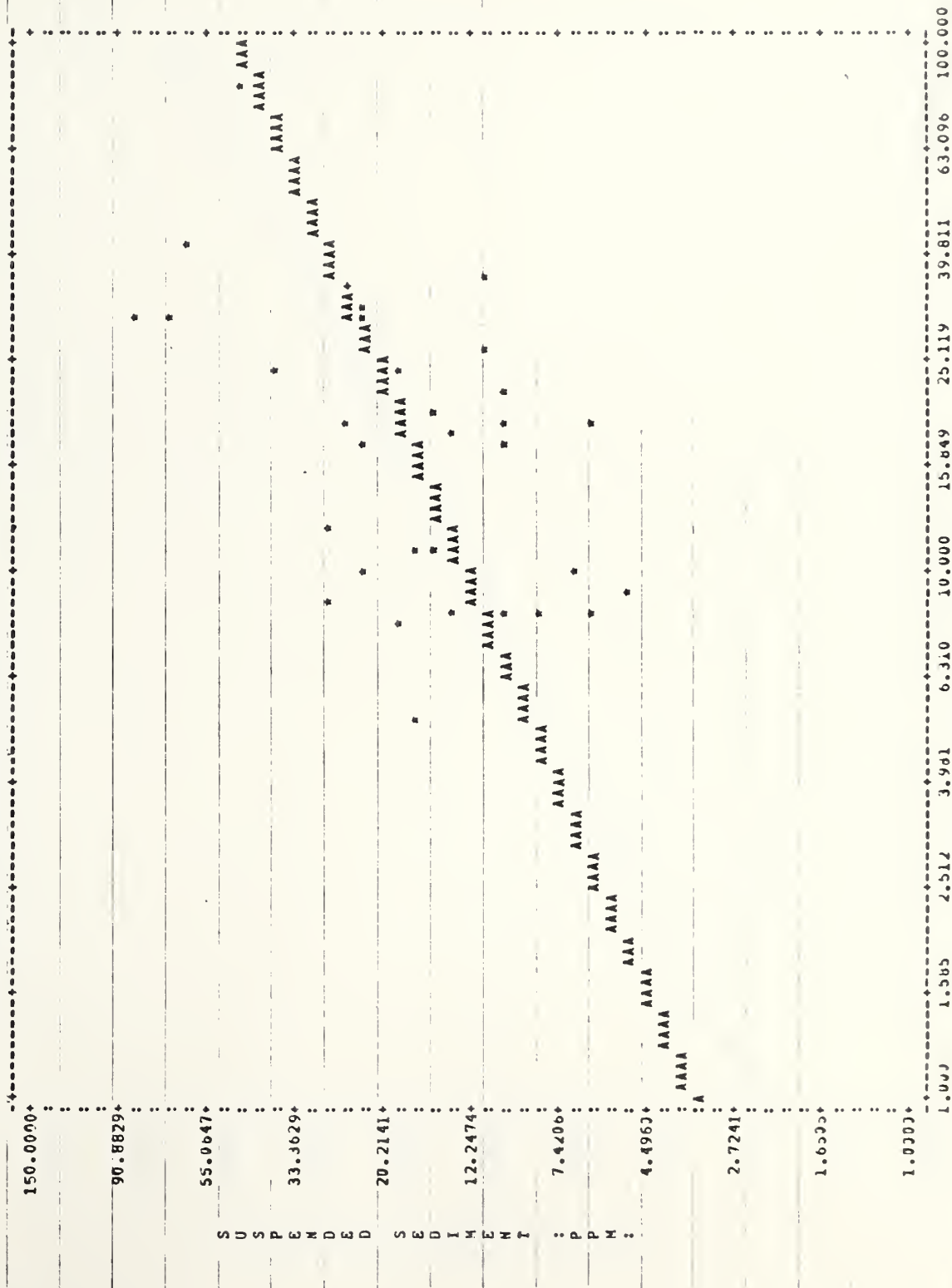
## Hydrochemical Parameters

The concentration of dissolved solids is inversely related to stream discharge so that lowest concentrations occur during periods of high runoff, while highest concentrations are found during periods of low summer base flow (Gunnerson, 1967; Gregory and Walling, 1973, pp. 219-225). Patterns for



FIGURE 26. SUSPENDED SEDIMENT VS STREAM DISCHARGE -LOWER MOOSE

LOG SED = 0.5395 + 0.5622 (LOG DIS)

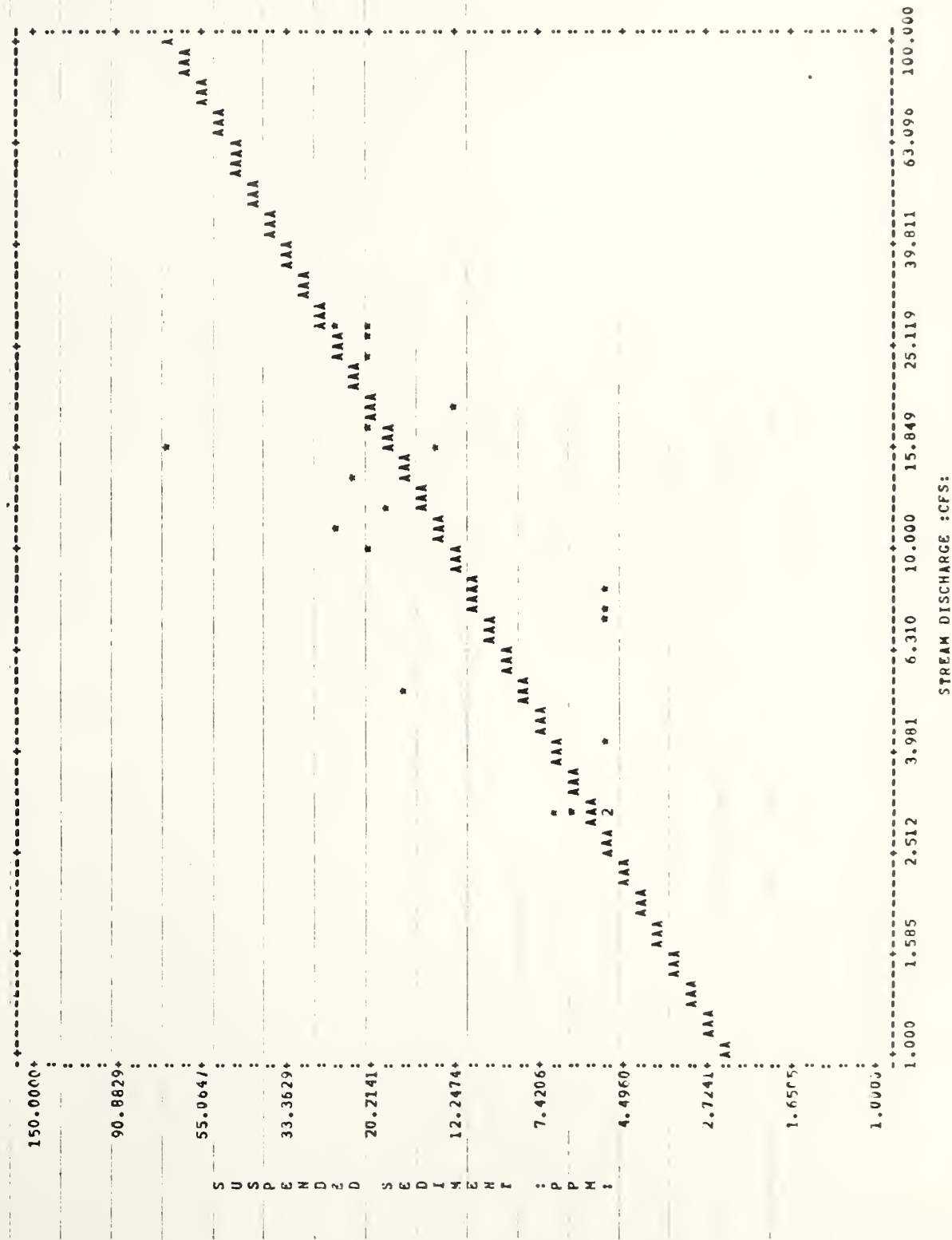


STREAM DISCHARGE : CFS:



FIGURE 27. SUSPENDED SEDIMENT VS STREAM DISCHARGE - UPPER MOOSE

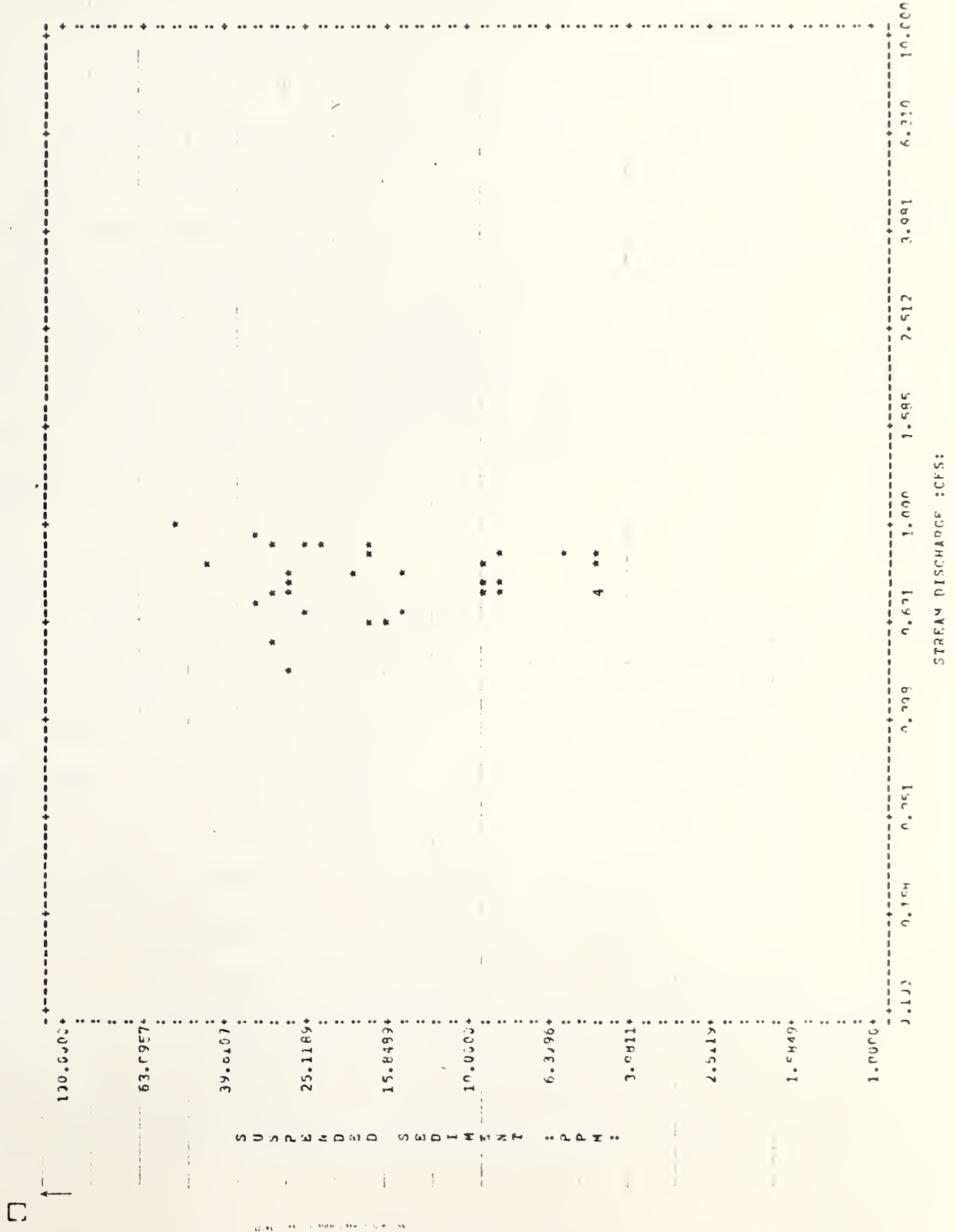
LOG SED = 0.3993 + 0.7088 (LOG DIS)



STREAM DISCHARGE : CFS:



FIGURE 28. SUSPENDED SEDIMENT VS STREAM DISCHARGE - MACLEAN





specific ions, especially the ecologically important ones, often vary from this generalization (Likens, et al., 1977, pp. 74-76).

Specific conductance for the Lower Moose Creek station ranged from a low of 128 umhos during high spring runoff to a high of 248 umhos during late summer base flow. The Upper Moose station exhibited a similar pattern, values ranging from 123 umhos to a high of 238 umhos. A low range, 287 umhos to 348 umhos, was noted in MacLean Creek. The relationships between specific conductance and stream discharge for both Moose Creek stations (Figures 29 and 30) significant, MacLean Creek (Figure 31) was not. Variation in specific conductance with stream discharge is partially attributed to seasonal and storm hysteresis effects (Gregory and Walling, 1973, pp. 219-225). The ranges in ionic concentration for specific ions are present in Tabel 10.

#### Bacteria Levels

The concentration of fecal and total coliform in streams draining rangeland watersheds is directly related to the number of cattle present, their access to the stream, the physical and hydrological characteristics of the basin, local weather conditions (Kunkle, 1970; Stephensen and Street, 1978), and the time of day (Kunkle and Meiman, 1968). Seasonal patterns include a spring "flushing" effect during the rising state (Kunkle and Meiman, 1968), with high counts during the low flow summer period, counts which often continue for some period after the cattle have been removed from the area (Stephensen and Street, 1978). This seasonal pattern may briefly be modified by local storms which produce their one "flushing" effect, and which may or may not be followed by a short term dilution period.



FIGURE 29. CONDUCTIVITY VS STREAM DISCHARGE - LOWER MOOSE

LOG COND = 2.5979 - 0.273 (LOG DIS)

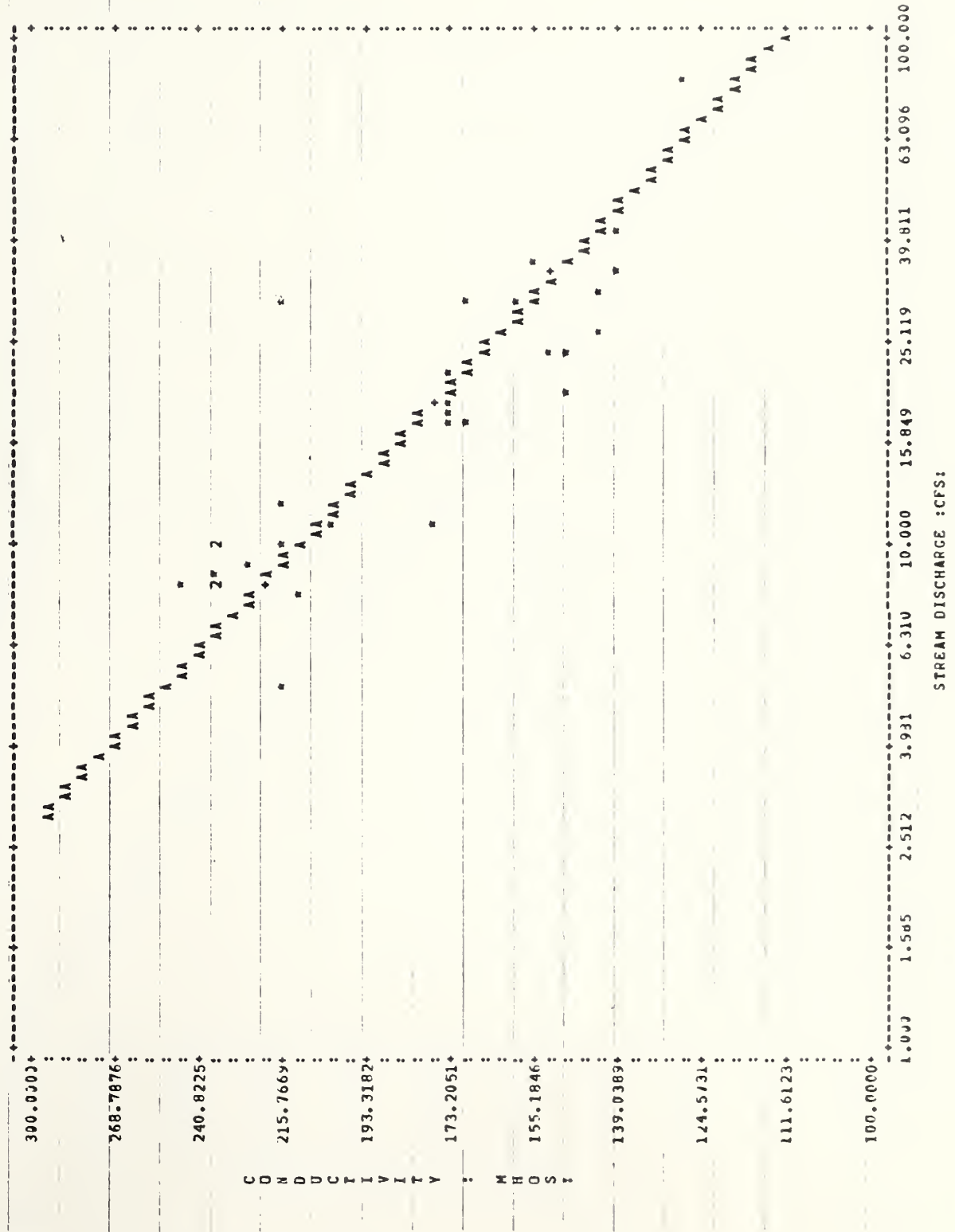
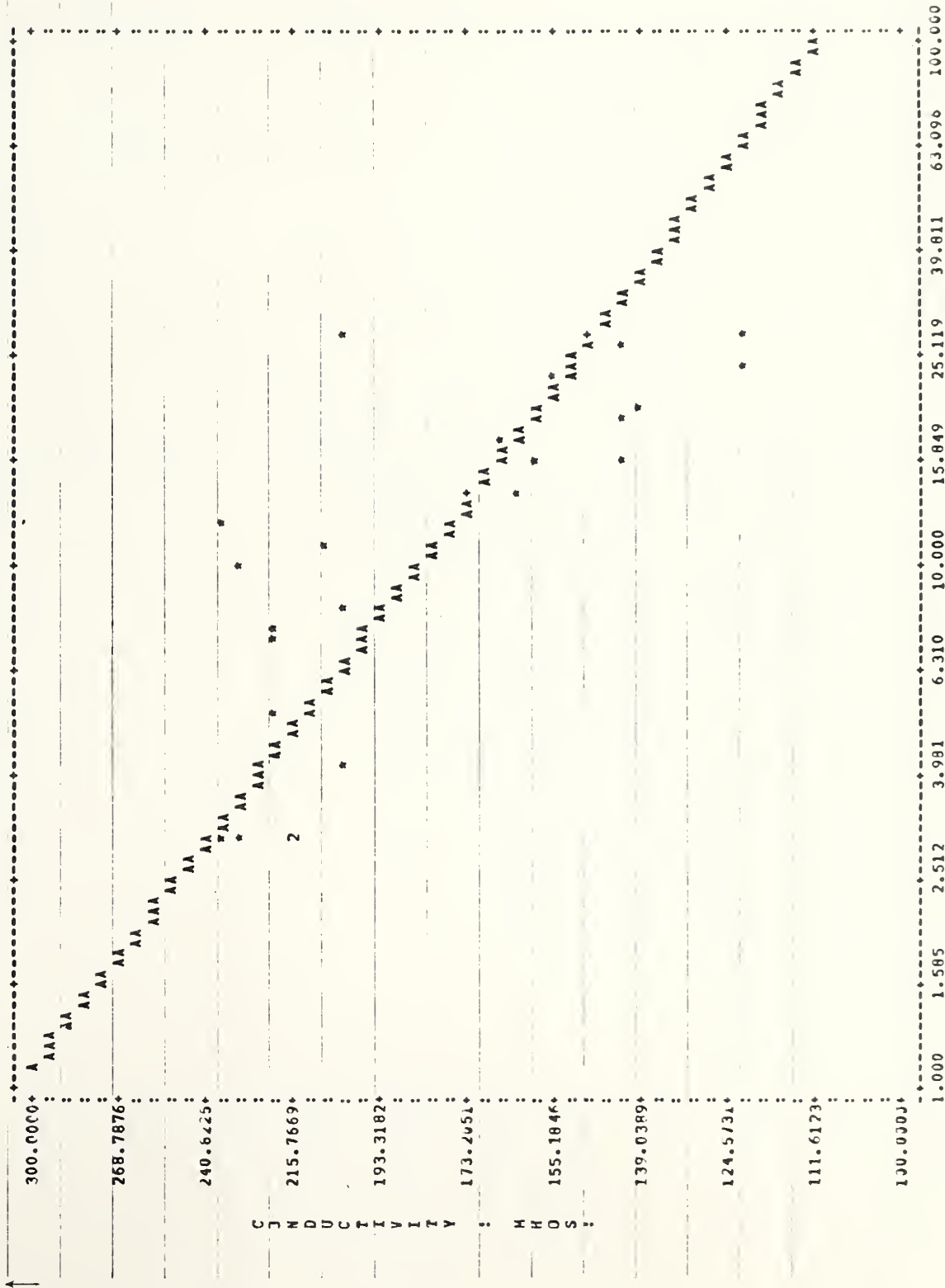




FIGURE 30. CONDUCTIVITY VS STREAM DISCHARGE - UPPER MOOSE

LOG COND = 2.4852-0.220 (LOG DIS)



STREAM DISCHARGE : CFS:



FIGURE 31. CONDUCTIVITY VS STREAM DISCHARGE - MACLEAN

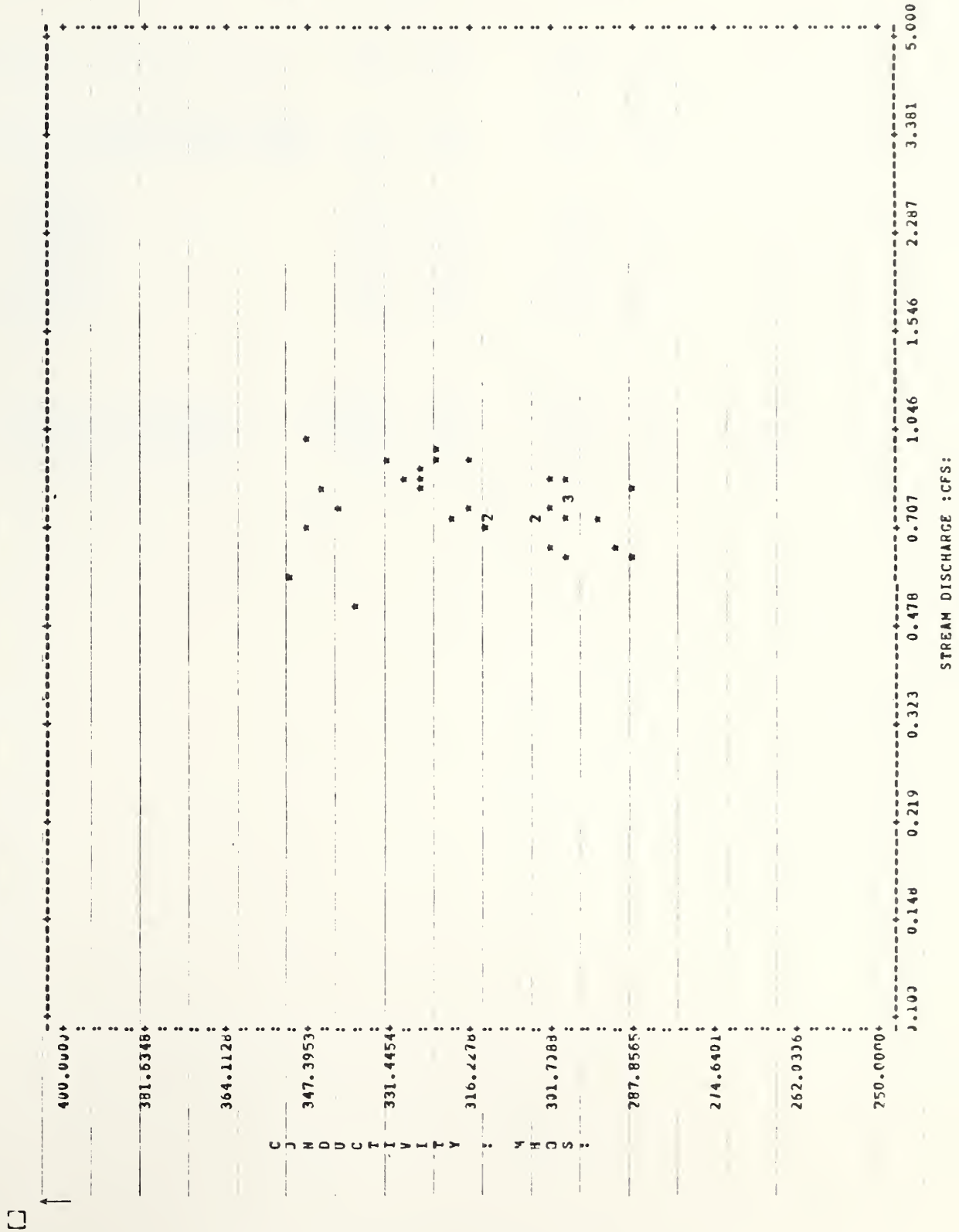




Table 10 Ranges of Hydrochemical Characteristics for the Moose Creek Sample Stations for 1977 - 1978.

	Lower Moose	MacLean	Upper Moose
pH	7.20 - 8.25	7.45 - 8.16	6.95 - 7.90
Alkalinity ( $\text{CaCO}_3$ ) (mg/l)	57 - 141	130 - 158	56 - 131
Specific Conductance ( $\mu\text{mhos}$ )	128 - 248	287 - 348	123 - 238
Total Dissolved Solids (mg/l)	83 - 162	187 - 226	80 - 155
Ca (mg/l)	16 - 39	30 - 44	15 - 38
Mg (mg/l)	5.6 - 14	6.9 - 19	4.8 - 13
Na (mg/l)	3.2 - 6.1	7.0 - 9.0	2.9 - 5.9
K (mg/l)	1.3 - 3.2	1.8 - 3.7	1.3 - 2.9
$\text{HCO}_3$ (mg/l)	68 - 172	158 - 193	96 - 159
$\text{SO}_4$ (mg/l)	2 - 17	13 - 26	5 - 16
$\text{NH}_4$	< .01 - .10	< .01 - .12	< .01 - .10
$\text{NO}_2 + \text{NO}_3 - \text{N}$ (mg/l)	< .01 - .11	.01 - .81	< .01 - .09
$\text{PO}_4$ (Ortho) -P (mg/l)	.007 - .075	.016 - .044	.004 - .087



The concentrations of fecal coliform for the Lower Moose, Upper Moose, and MacLean stations for the study period are presented in Table 11. Higher values generally occurred during the grazing season, especially during periods when cattle were known to be present. Maximum recorded levels were 317 colonies/100 mls for Lower Moose, 670 for the Upper station, and 14 for the MacLean station. Low values were associated with the spring season. Approximately 17 percent and 8 percent of sample coliform counts for Lower and Upper Moose Creek exceeded the 200 colony/100 mls limit of the Montana Water Quality Criteria. MacLean Creek samples had no exceptions.

#### Comments

Because of the limited number of samples taken and the nature of the hydrochemical parameters evaluated, relationships between the water quality characteristics within the Moose Creek basin and the Montana Water Quality Criteria cannot be addressed.



Table 11 Fecal Coliform Concentrations (colonies/mls) for the Moose Creek Sample Stations, 1977 - 1978

	1977	1978	MacLean		Upper Moose	
	1977	1978	1977	1978	1977	1978
April		--		--		--
May	60	48*	2	< 2	10	26
June	2	123*	2(?)	3(?)	17(?)	22
July	2(?)	10(?)	12*	1(?)	4*	50*
August	224*	40(?)	12*	4(?)	68*	127*
September	30(?)	317(?)	14*	2(?)	20*	670*
October	2(?)		2*		13	
November	< 2		2			

\* Stock visually present

(?) Stock presence uncertain



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# APPENDIX

## BASIC DATA RECORD

Station: Lower Camp				Stream Reach Score: (BLM)			
Location: S 20 T 2S R 8W				Survey Date:			
Water Year: 1977							
Date	1976	1977	1977	4/20	5/10	5/18	
Time	9/23	10/28	2/27	1700	1345	1230	
		1030	1415				
Temperature (F°)							
air	36	43	32	50	63	46	
water	32	33	32	41	48	40	
water (max)	52	40	ice	54	53	48	
water (min)	32	32	ice	32	41	36	
Precipitation (in)							
Discharge (cfs)							
instant	6.1	4.3	4.3	9.5	7.0	7.9	
crest stage				19	11	14	
Suspended sediment (ppm)	28	7	14	9	< 5	< 5	
Chemical Character							
PH							
ALK (CaCO <sub>3</sub> ) (mg/l)				7.69			
SC (µmhos)	178	178	186	49	135	162	
TDS (mg/l)	116	116	121	147	88	105	
Ca				96			
Mg				13			
Na				5.4			
K				5.0			
HCO <sub>3</sub>				2.6			
SO <sub>4</sub>				59			
NH <sub>4</sub>				24			
NO <sub>2</sub> -N				--			
PO <sub>4</sub> (Ortho)-P				.04			

Biological Character				n - No			
Total Coliform							
(colonies/100 ml)							
Fecal Coliform							
(colonies/100 ml)							
Stock present							



## BASIC DATA RECORD

Station: Lower Camp				Stream Reach Score: (BLM)			
Location: S 20 T 2S R 8W				Survey Date:			
Water Year: 1977							
Date	5/27	6/11	6/24	7/16	7/28	8/31	9/29
Time	0845	0930	0930	0900	1800	1000	1000
Temperature (F°)							
air	39	50	64	61	72	40	37
water	43	48	55	55	59	45	44
water (max)	48	63	62	61	63	62	59
water (min)	39	41	48	50	54	45	43
Precipitation (in)							
Discharge (cfs)							
instant	11	13	5.6	2.4	3.4	5.8	4.1
crest stage	11	16	14	7.3	7.3	5.8	5.8
Suspended sediment (ppm)							
	22	23	14	< 5	11	15	< 5
Chemical Character							
PH	7.62		7.32		7.85	7.80	8.00
ALK (CaCO <sub>3</sub> ) (mg/l)	47		56		65	72	107
SC (µmhos)	152	145	163	152	158	158	193
TDS (mg/l)	99	94	106	99	103	103	125
Ca	17		17		19	22	28
Mg	5.1		5.8		6.8	7.9	10
Na	4.9		5.2		5.5	6.6	8.3
K	2.0		1.8		2.1	2.6	3.2
HCO <sub>3</sub>	58		68		80	88	131
SO <sub>4</sub>	21		20		20	17	22
NH <sub>4</sub>	--		.04		--	<.01	.04
NO <sub>2</sub> & NO <sub>3</sub> -N	<.01		.03		.06	.14	.08
PO <sub>4</sub> (Ortho)-P	.012		.035		.050	.040	.034
Biological Character							
Total Coliform (colonies/100 mls)	120		12		117	82	31
Fecal Coliform (colonies/100 mls)	98		34	y	124	42	16
Stock present		y	u		y	y	y



## BASIC DATA RECORD

Station: Lower Camp				Stream Reach Score: (BLM)			
Location: S 20 T 2S R 8W				Survey Date:			
Water Year: 1978				Survey Date:			
Date	1977	1978		4/11	4/18	4/25	5/3
Time	10/15	11/10		0930	1700	1415	1030
	0945	0945					
Temperature (F°)							
air	36	36	41	47	52	64	47
water	38	33	36	39	44	47	44
water (max)	49	45	inst	46	44	48	49
water (min)	35	32	inst	33	37	36	44
Precipitation (in)							
Discharge (cfs)							
instant	3.4	3.0	9.3	6.6	4.8	4.8	8.2
crest stage	4.8	4.6	11	9.7	9.7	6.6	12
Suspended sediment (ppm)	< 5	6	40	25	6	6	8
Chemical Character							
PH	7.95	7.93				6.85	
ALK (CaCO <sub>3</sub> ) (mg/l)	73	60				57	
SC (µmhos)	191	178	142	157	155	153	135
TDS (mg/l)	124	116	92	102	101	99	88
Ca	26	24				17	
Mg	9.1	7.7				6.3	
Na	7.6	6.6				5.1	
K	2.4	2.0				1.3	
HCO <sub>3</sub>	88	73				68	
SO <sub>4</sub>	23	24				14	
NH <sub>4</sub>	.01	< .01				.08	
NO <sub>3</sub> -N	.09	.14				.01	
PO <sub>4</sub> (Ortho)-P	.021	.027				.018	
Biological Character							
Total Coliform (colonies/100 mls)	3	63				259	
Fecal Coliform (colonies/100 mls)	3	7				--	
Stock present	y	y	n	n	n	n	n



## BASIC DATA RECORD

Station: Lower Camp Stream Reach Score: (BLM)  
 Location: S 20 T 2S R 8W  
 Water Year: 1978 Survey Date: 6/20 1945

Date 5/9 5/15 5/23 5/30 6/7 6/14 6/30  
 Time 1400 1230 0930 1830 1700 1030 1945

Temperature (F°)

air 63 69 48 44 74 55 69  
 water 44 48 44 46 56 46 59  
 water (max) 49 54 set 54 58 57 59  
 water (min) 37 44 set -- 44 44 54

Precipitation (in)Discharge (cfs)

instant 11 32 76 31 33 32 14  
 crest stage 13 35 76 90 42 39 27

Suspended sediment (ppm)

18 106 107 37 51 37 22

Chemical Character

pH 7.05  
 ALK (CaCO<sub>3</sub>) (mg/l) 28  
 SC (μmhos) 135  
 TDS (mg/l) 88  
 Ca " 14  
 Mg " 3.9  
 Na " 4.4  
 K " 2.2  
 HCO<sub>3</sub> " 42  
 SO<sub>4</sub> " 12  
 NH<sub>4</sub> " .05  
 NO<sub>3</sub> & NO<sub>2</sub> -N " <.01  
 PO<sub>4</sub> (Ortho) -P " .025

Biological Character

Total Coliform (colonies/100 mls) 1340 1200  
 Fecal Coliform (colonies/100 mls) <2 10  
 Stock present n y y y y y y



# BASIC DATA RECORD

Station: Lower Camp  
 Location: S 20 T 2S R 8W  
 Water Year: 1978  
 Stream Reach Score: (BLM)  
 Survey Date: \_\_\_\_\_

Date	7/17	8/17	9/12
Time	1800	2115	1630
Temperature (F°)			
air	69	44	38
water	59	47	45
water (max)	--	63	58
water (min)	--	45	45
Precipitation (in)			
Discharge (cfs)			
instant	7.6	5.4	17
crest stage	22	20	17
Suspended sediment (ppm)	16	23	35
Chemical Character			
PH	7.15	7.78	7.05
ALK (CaCO <sub>3</sub> ) (mg/l)	56	58	66
SC (µmhos)	162	178	171
TDS (mg/l)	105	116	111
Ca	17		18
Mg	6.2		5.8
Na	4.8		5.7
K	2.1		2.8
HCO <sub>3</sub>	68	70	81
SO <sub>4</sub>	36	22	34
NH <sub>4</sub>	.02	<.01	.06
NO <sub>3</sub> & NO <sub>2</sub> -N	.04	.04	.01
PO <sub>4</sub> (Ortho) -P	.043	.053	.038

Biological Character			
Total Coliform (colonies/100 mls)	1830	183	4210
Fecal Coliform (colonies/100 mls)	19	19	340
Stock present	u	u	y



Wickiup 75  
Camp 70

Stream Reach Score: Little Camp 53

Survey Date: 8/12/76

# BASIC DATA RECORD

Station: Upper Camp  
Location: S 1 T 2S R 8W  
Water Year: 1977

Date 1976  
Time 9/23

Temperature (F°)  
air 39  
water 32  
water (max) --  
water (min) --

Precipitation (in)

Discharge (cfs)  
instant 4.6  
crest stage 4.9

Suspended sediment (ppm)  
12

Chemical Character  
PH  
ALK (CaCO<sub>3</sub>) (mg/l)  
SC (µmbos)  
TDS (mg/l)

Ca "  
Mg "  
Na "  
K "  
HCO<sub>3</sub> "  
SO<sub>4</sub> "  
NH<sub>4</sub> "  
NO<sub>2</sub> & NO<sub>3</sub>-N "  
PO<sub>4</sub> (Ortho)-P "

## Biological Character

Total Coliform  
(colonies/100 mls)  
Fecal Coliform  
(colonies/100 mls)  
Stock present

1977  
4/13  
1630

11/19  
1545

36  
34  
41  
34

4.8  
4.9

48  
< 5

133  
86

10  
3.8  
4.3  
2.3  
45  
20  
--  
0.07  
--

4/20  
1615

44  
38  
45  
34

inst

7.0  
18

31

117  
76

10  
3.8  
4.3  
2.3  
45  
20  
--  
0.07  
--

4/30  
1215

64  
41  
47  
33

0.09

7.7  
16

10

112  
73

10  
3.8  
4.3  
2.3  
45  
20  
--  
0.07  
--

5/10  
1430

64  
41  
47  
52  
35

0.70

5.8  
12

6

132  
86

10  
3.8  
4.3  
2.3  
45  
20  
--  
0.07  
--

5/18  
1300

45  
41  
54  
37

1.01

6.0  
14

9

132  
86

10  
3.8  
4.3  
2.3  
45  
20  
--  
0.07  
--

5/27  
0915

41  
41  
53  
36

1.23

9.8  
12

10

127  
83

14  
3.8  
4.3  
1.7  
42  
20  
--  
0.07  
--



Wickiup  
Camp  
Little Camp

75  
70  
53

Stream Reach Score:

Survey Date: 8/12/76

# BASIC DATA RECORD

Station: Upper Camp  
Location: S 1 T 2S R 8W  
Water Year: 1977

Date 6/11 6/24 7/16 7/28 8/31 9/21 9/29  
Time 1030 1030 1000 1715 1045 1015 1045

## Temperature (F°)

air 50 59 72 71 41 37 50  
water 47 54 54 63 44 43 46  
water (max) 68 63 65 65 64 51 50  
water (min) 36 45 45 50 44 41 37

Precipitation (in) 1.18 1.27 0.81 1.07 1.45 1.26 0.42

## Discharge (cfs)

instant 10 6.3 4.2 3.6 4.4 4.0 3.0  
crest stage 16 15 6.8 8.3 4.4 7.4 5.5

## Suspended sediment (ppm)

42 22 12 < 5 < 5 < 5 < 5

## Chemical Character

PH 7.30  
ALK (CaCO<sub>3</sub>) (mg/l) 45  
SC 128 125 118 45 7.70 53 7.60  
TDS 83 82 77 79 83 96 96  
Ca 14  
Mg 4.2  
Na 4.3  
K 1.5  
HCO<sub>3</sub> 54  
SO<sub>4</sub> 14  
NH<sub>4</sub> .04  
NO<sub>3</sub> & NO<sub>2</sub>-N < .01  
PO<sub>4</sub> (Ortho) .013 .045 .028 .05 .06 .027

## Biological Character

Total Coliform 262 43 85 9  
(colonies/100 ml)  
Fecal Coliform 249 29 58 7  
(colonies/100 ml)  
Stock present y u y y



Wickiup	75
Camp	70
Little Camp	53

Stream Reach Score:

Stream Reach Score: Little  
Survey Date: 8/12/76

Survey Date: 8/12/76

	4/11	4/18	4/25	5/3	5/9	5/15
	1000	1600	1330	1130	1500	1345
36	46	45	67	44	53	61
41	37	42	47	44	46	48
inst	47	45	48	47	54	--
inst	32	32	32	36	32	--

foot	0.24	0.16	0.47	0.71	1.21	0.31
------	------	------	------	------	------	------

7.4	6.2	5.3	5.5	7.2	9.5	26
7.9	6.2	6.6	8.5	10	26	
get						

	7	7	16	10	14	25	50
--	---	---	----	----	----	----	----

121	125	6.73	7.25
79	81	42	28
		122	92
		79	60
		112	114
		73	74
		15	9.8
		4.4	2.9
		4.9	3.5
		1.8	1.3
		50	34
		12	12
		.03	.03
		.01	.01
		.015	.025

405	393	u	u	u	u
✓ 2	—	u	u	u	u
u	u	u	u	u	u



Wickiup  
Camp  
Little Camp

75  
70  
53

Stream Reach Score:

Survey Date: 8/12/76

# BASIC DATA RECORD

Station: Upper Camp  
Location: S 1 T 2S R 8W  
Water Year: 1978

Date  
Time

Temperature (F°)

air  
water  
water (max)  
water (min)

Precipitation (in)

Discharge (cfs)

instant  
crest stage

Suspended  
sediment (ppm)

Chemical Character

PH

ALK (CaCO<sub>3</sub>) (mg/l)  
SC (μmhos)  
TDS (mg/l)

Ca

Mg

Na

K

HCO<sub>3</sub>

SO<sub>4</sub>

NH<sub>4</sub>

NO<sub>2</sub> & NO<sub>3</sub>-N

PO<sub>4</sub> (Ortho)-P

Biological Character

Total Coliform

(colonies/100 mls)

Fecal Coliform

(colonies/100 mls)

Stock present

5/23 5/30  
1100 1730

59 45  
46 43  
set set  
set set

2.01 0.45

70 29  
70 70

54 23

98 100  
64 65

89 58

88 57

10 13

3.2 4.2

3.5 4.5

1.3 1.8

33 53

16 25

.01 .01

<.01 <.01

.030 .038

6/14 6/20  
1115 1000

59 50  
46 42  
set 59  
set 39

0.39 0.33

28 22  
35 30

33 24

88 115  
57 75

10 13

3.2 4.2

3.5 4.5

1.3 1.8

33 53

16 25

.01 .01

<.01 <.01

.030 .038

6/30 6/30  
1915 1915

65 63  
59 52  
64 68  
42 45

0.55 1.24

16 10  
22 17

26 20

115 131  
75 85

10 13

3.2 4.2

3.5 4.5

1.3 1.8

33 53

16 25

.01 .01

<.01 <.01

.030 .038

7/17 7/17  
1715 1715

42 42  
47 47  
-- --  
43 43

1.73 1.73

10 10  
18 18

24 24

7.24 7.24  
47 47  
138 138  
90 90

15 15

4.2 4.2

4.4 4.4

1.4 1.4

57 57

22 22

<.01 <.01

<.01 <.01

.034 .048

8/12 8/12  
1500 1500

35 35  
42 42  
61 61  
42 42

3.25 3.25

16 16  
16 16

30 30

6.70 6.70  
46 46  
148 148  
46 46

9.5 9.5

4.6 4.6

4.9 4.9

2.0 2.0

56 56

26 26

<.01 <.01

<.01 <.01

.034 .034

83

2980 633 3880

147 83 523

u u y



## BASIC DATA RECORD

Station: Lower Moose				Stream Reach Score: 44			
Location: S 23 T 1S R 9W				Survey Date: 9/23/76			
Water Year: 1977							
Date	1976	1977		4/30	5/10	5/18	5/27
Time	10/28	2/27		1000	1700	1615	1215
	1515	1515					
Temperature (F°)							
air	59	34		50	59	46	46
water	36	32		38	47	40	43
water (max)	48	41		46	51	54	47
water (min)	32	32		35	36	37	37
Precipitation (in)							
Discharge (cfs)							
instant	10	9.3		26	22	19	37
crest stage	set	15		74	33	41	42
Suspended sediment (ppm)							
	(45)	< 5		11	10	10	11
Chemical Character							
PH							7.84
ALK (CaCO <sub>3</sub> ) (mg/l)							65
SC (µmhos)	235	225		142	172	178	155
TDS (mg/l)	153	146		92	112	116	101
Ca							21
Mg							5.6
Na							4.0
K							1.6
HCO <sub>3</sub>							80
SO <sub>4</sub>							13
NH <sub>4</sub>							--
NO <sub>3</sub> & NO <sub>2</sub> -N							.02
PO <sub>4</sub> (Ortho)-P							.012

## Biological Character

Total Coliform  
(colonies/100 mls)  
Fecal Coliform  
(colonies/100 mls)  
Stock present

96

60



## BASIC DATA RECORD

Station: Lower Moose			Stream Reach Score: 44				
Location: S 23 T 1S R 9W			Survey Date: 9/23/76				
Water Year: 1977							
Date	6/12	6/24	7/16	7/28	8/31	9/21	9/29
Time	1215	1330	1330	1700	1400	1530	1345
Temperature (F°)							
air	57	73	82	81	54	51	60
water	50	61	46	59	46	47	47
water (max)	53	70	61	61	63	55	47
water (min)	46	48	44	50	44	41	39
Precipitation (in)							
Discharge (cfs)							
instant	30	11	5.3	8.0	8.5	10	8.3
crest stage	50	30	11	15	9.2	17	13
Suspended sediment (ppm)							
	65	15	16	18	10	7	6
Chemical Character							
PH		7.99		8.19	8.25		8.05
ALK (CaCO <sub>3</sub> ) (mg/l)		96		112	141		109
SC (µmhos)	170	203	218	210	248	218	235
TDS (mg/l)	110	132	142	136	162	142	153
Ca		27		29	39		32
Mg		7.9		9.6	14		11
Na		4.7		5.1	6.1		6.0
K		1.6		1.9	2.4		2.4
HCO <sub>3</sub>		117		137	172		132
SO <sub>4</sub>		8		12	13		16
NH <sub>4</sub>		.07		--	<.01		.10
NO <sub>2</sub> & NO <sub>3</sub> -N		<.01		.03	.11		.07
PO <sub>4</sub> (Ortho) -P		.025		.038	.016		.027
Biological Character							
Total Coliform	14		107		225		30
(colonies/100 mls)							
Fecal Coliform	< 2		< 2		224		30
(colonies/100 mls)							
Stock present	u	u	u	u	y	u	u



# BASIC DATA RECORD

Station:	Lower Moose				
Location: S 23 T 1S R 9W					
Water Year:	1978				
Date	1977				
Time	10/15 1345				
Temperature (F°)					
air	63				
water	38				
water (max)	48				
water (min)	33				
Stream Reach Score:	44				
Survey Date:	9/23/76				
4/5	4/11	4/18	4/25	5/3	5/9
1245	1345	1415	1015	1445	1130
1978	3/29				
0915					
49	52		61	48	49
35	44		44	46	41
set	46		47	50	49
set	35		35	42	(32)

[illegible]

Suspended sediment (ppm)	8	13	37	13	6	17	23	15	22
--------------------------	---	----	----	----	---	----	----	----	----

Chemical Character		8.00	8.00	8.00	7.20
PH					
ALK (CaCO <sub>3</sub> ) (mg/l)		105	105		92
SC (μmos)		223	235		175
TDS (mg/l)		145	153		114
				172	178
		150		112	116
		98			
					23
Ca	"	28	34		
Mg	"	9.1	11		8.0
Na	"	4.9	5.6		4.3
K	"	1.6	1.6		1.4
HCO <sub>3</sub>	"	128	128		111
SO <sub>4</sub>	"	11	10		8
NH <sub>4</sub>	"	.03	< .01		.03
NO <sub>2</sub>	"	.11	.11		.11
PO <sub>4</sub> (Ortho)-P	"	.028	.007		.015
					150
					98
					158
					103

<u>Biological Character</u>					
Total Coliform (colonies/100 mls)	9	15			2500
Fecal Coliform (colonies/100 mls)	2	< 2	--		--
Stock present	u	n	n	n	n



## BASIC DATA RECORD

Station: Lower Moose  
 Location: S 23 T 1S R 9W  
 Water Year: 1978

Stream Reach Score: 44  
 Survey Date: 9/23/76

Date	5/15	5/23	5/30	6/7	6/14	6/20	6/30	7/17	8/15
Time	1545	1530	1530	1430	1515	1230	1745	1315	1730
Temperature (F°)									
air	49	61	52	74	71	64	72	63	68
water	48	50	46	55	55	55	61	57	55
water (max)	53	set	set	59	59	56	63	65	66
water (min)	41	set	set	41	44	46	47	50	48
Precipitation (in)									
Discharge (cfs)									
instant	35	84	34	31	24	19	12	10	8.6
crest stage	71	122	101	46	31		20	22	11
Suspended sediment (ppm)									
	25	45	24	22	19	25	26	22	28
Chemical Character									
PH	7.40					7.81		7.97	8.12
ALK (CaCO <sub>3</sub> ) (mg/l)	57					86		106	120
SC (µmhos)	138	128	153	143	152	178	218	235	238
TDS (mg/l)	90	83	99	93	99	116	142	153	155
Ca	16					21		28	30
Mg	5.6					6.8		9.3	9.2
Na	3.2					4.1		4.8	4.9
K	1.4					1.3		1.9	1.9
HCO <sub>3</sub>	68					104		129	146
SO <sub>4</sub>	2					10		14	14
NH <sub>4</sub>	.05					.01		.02	<.01
NO <sub>3</sub> -N	.01					<.01		.05	.02
PO <sub>4</sub> (Ortho)-P	.023					.075		.042	.045

## Biological Character

Total Coliform	415	2900	2630	17500	87
(colonies/100 mls)					
Fecal Coliform	48	123	10	40	
(colonies/100 mls)	y	y	u	u	
Stock present			n		



## BASIC DATA RECORD

Station: Lower Moose  
 Location: S 23 T 1S R 9W  
 Water Year: 1978

Stream Reach Score: 44

Survey Date: 9/23/76

Date 9/12  
 Time 0915

Temperature (F°)  
 air 36  
 water 45  
 water (max) 60  
 water (min) 45

Precipitation (in)

Discharge (cfs)  
 instant 30  
 crest stage 20

Suspended sediment (ppm) 81

Chemical Character

PH	<u>7.55</u>
ALK (CaCO <sub>3</sub> ) (mg/l)	<u>87</u>
SC (µmhos)	<u>218</u>
TDS (mg/l)	<u>142</u>
Ca	<u>24</u>
Mg	<u>8.3</u>
Na	<u>5.2</u>
K	<u>2.6</u>
HCO <sub>3</sub>	<u>108</u>
SO <sub>4</sub>	<u>17</u>
NH <sub>4</sub>	<u>&lt;.01</u>
NO <sub>3</sub> & NO <sub>2</sub> -N	<u>&lt;.01</u>
PO <sub>4</sub> (Ortho)-P	<u>.036</u>

Biological Character

Total Coliform (colonies/100 mls)	<u>10300</u>
Fecal Coliform (colonies/100 mls)	<u>317</u>
Stock present	<u>u</u>



## BASIC DATA RECORD

Station: Upper Moogee  
 Location: S 9 T 15 R 8W  
 Water Year: 1977

Stream Reach Score: 66Survey Date: 8/12/76

Date	1976	1977	1977	5/10	5/18	5/27	6/12	6/24
Time	9/22	11/19	4/30	1545	1445	1045	1045	1200
		1400	1400					
Temperature (F°)								
air		43	66	63	46	40	52	70
water		36	42	51	41	41	50	57
water (max)			inst	56	50	42	50	66
water (min)			inst	34	36	39	31	46
Precipitation (in)			inst	0.72	0.98	1.92	1.62	1.02
Discharge (cfs)								
instant	7.5	7.3	20	16	14	28	23	4.2
crest stage		set	set	26	27	35	33	23
Suspended sediment (ppm)								
	(147)	< 5	< 5	69	< 5	< 5	6	5
Chemical Character								
pH			7.32			7.62		7.59
ALK (CaCO <sub>3</sub> ) (mg/l)			64			63		96
SC (µmhos)			138			148		200
TDS (mg/l)			90			96		130
Ca			16			19		25
Mg			5.4			5.4		8.0
Na			2.8			3.5		3.8
K			2.0			1.4		1.5
HCO <sub>3</sub>			79			77		117
SO <sub>4</sub>			9			12		8
NH <sub>4</sub>			--			--		.10
NO <sub>2</sub> & NO <sub>3</sub> -N			--			<.01		.01
PO <sub>4</sub> (Ortho) -P			--			.011		.087

## Biological Character

Total Coliform  
 (colonies/100 mls)  
 Fecal Coliform  
 (colonies/100 mls)  
 Stock present

9

10



# BASIC DATA RECORD

Station: Upper Moose  
 Location: S 9 T 15 R 8W  
 Water Year: 1977  
 Stream Reach Score: 66  
 Survey Date: 8/12/76

Date	7/16	7/28	8/31	9/21	9/29
Time	1130	1400	1215	1230	1215
Temperature (F°)					
air	75	77	51	39	54
water	55	61	46	44	46
water (max)	68	66	61	57	50
water (min)	45	50	42	49	36
Precipitation (in)	1.33	> 0.47	1.06	1.86	0.61
Discharge (cfs)					
instant	5.2	≤ 3.0	≤ 3.0	8.2	≤ 3.0
crest stage	6.4	5.2	≤ 4.0	16	12
Suspended sediment (ppm)	17	7	6	< 5	< 5
Chemical Character					
PH		7.84	7.65		7.85
ALK (CaCO <sub>3</sub> ) (mg/l)		115	131		78
SC (µmbos)	222	218	238	204	228
TDS (mg/l)	144	142	155	113	148
Ca		30	38		37
Mg		10	13		13
Na		4.0	4.9		5.9
K		1.8	2.3		2.9
HCO <sub>3</sub>		140	159		95
SO <sub>4</sub>		11	11		13
NH <sub>4</sub>		--	<.01		.01
NO <sub>2</sub> & NO <sub>3</sub> -N		<.01	.06		.06
PO <sub>4</sub> (Ortho)-P		.023	.004		.013

Biological Character					
Total Coliform	30	88	15		
(colonies/100 mls)					
Fecal Coliform	4	68	20		
(colonies/100 mls)					
Stock present	y	y	y	y	y



## BASIC DATA RECORD

Station: Upper Moose  
 Location: S 9 T 1S R 8W  
 Water Year: 1978

Stream Reach Score: 66Survey Date: 8/12/76

Date  
Time

1977		1978	
10/15	4/25	5/3	5/15
1215	1045	1315	1545

## Temperature (F°)

air	55	59	45	55	72	58	59	67
water	38	42	48	48	54	55	51	61
water (max)	46	50	52	59	63	67	57	65
water (min)	34	32	38	34	39	42	43	54

## Precipitation (in)

0.62	inst	0.52	0.67	2.29	0.16	0.36	0.53	0.55
------	------	------	------	------	------	------	------	------

## Discharge (cfs)

instant	14	16	28	26	24	19	17	11
crest stage	set	16	43	53	37	25	20	17

## Suspended

## sediment (ppm)

< 5	23	14	20	21	21	12	20	25
-----	----	----	----	----	----	----	----	----

## Chemical Character

PH		7.90		6.95	
ALK (CaCO <sub>3</sub> ) (mg/l)	80	108	80	56	7.15
SC (µmhos)	162	215	162	123	82
TDS (mg/l)	105	140	105	80	164
Ca	30	30	22	15	107
Mg	11	11	7.3	4.8	22
Na	4.6	4.6	3.7	2.9	7.3
K	1.9	1.9	1.4	1.3	4.2
HCO <sub>3</sub>	132	132	96	67	1.5
SO <sub>4</sub>	13	13	8	8	98
NH <sub>4</sub>	.04	.04	.03	.05	5
NO <sub>3</sub> & NO <sub>2</sub> -N	.09	.09	<.01	<.01	<.01
PO <sub>4</sub> (ortho)-P	.014	.014	.011	.015	.050

## Biological Character

Total Coliform (colonies/100 mls)	8	2560	700	4100
Fecal Coliform (colonies/100 mls)	13	--	26	22
Stock present	n	n	n	n



## BASIC DATA RECORD

Stream Reach Score: 66  
 Survey Date: 8/12/76

Station: Upper Moose  
 Location: S 9 T 15 R 8W  
 Water Year: 1978

Date	7/17	8/17	9/12
Time	1315	1630	1200
Temperature (F°)			
air	65	42	36
water	57	46	39
water (max)	64	64	--
water (min)	47	44	--
Precipitation (in)	1.89	>0.66	3.29
Discharge (cfs)			
instant	9.8	12	27
crest stage	24	>12	27
Suspended sediment (ppm)	21	18	25
Chemical Character			
PH	7.70	7.82	7.10
ALK (CaCO <sub>3</sub> ) (mg/l)	108	102	75
SC (umhos)	230	235	202
TDS (mg/l)	150	153	131
Ca	27	29	23
Mg	9.6	8.9	7.8
Na	4.1	4.8	4.6
K	1.8	1.9	2.8
HCO <sub>3</sub>	132	124	91
SO <sub>4</sub>	10	12	16
NH <sub>4</sub>	.03	<.01	<.01
NO <sub>2</sub> & NO <sub>3</sub> -N	.05	.05	<.01
PO <sub>4</sub> (Ortho)-P	.035	.029	.024

## Biological Character

Total Coliform (colonies/100 mls)	4400	>40000	4330
Fecal Coliform (colonies/100 mls)	≤ 50	127	670
Stock present	y	y	y



## BASIC DATA RECORD

Station: MacLean  
 Location: S 23 T 1S R 9W  
 Water Year: 1977

Stream Reach Score: 48  
 Survey Date: 9/23/76

Date 1976  
Time  
 10/28 11/19 4/13 4/20 4/30 5/10 5/18 5/27  
 1415 1300 1300 1330 0945 1645 1545 1145

Temperature (F°)

air 45 41 50 46 49 59 46 46  
 water 36 34 36 36 39 44 39 41  
 water (max) 41 41 inst 43 44 46 46 45  
 water (min) 32 32 inst 32 36 36 36 36

Precipitation (in)

Discharge (cfs)  
 instant .95 .92 .90 .82 .87 .86 .83 .86  
 crest stage set 1.0 1.2 set .88 .86 .89 .89

Suspended sediment (ppm)  
 23 18 45 18 8 45 6 45

Chemical Character

PH 7.97  
 ALK (CaCO<sub>3</sub>) (mg/l) 144 7.76 149  
 SC (umhos) 301 301 325 300 325 325 328  
 TDS (mg/l) 196 196 211 195 211 211 213  
 Ca 30 30 35  
 Mg 6.9 6.9 14  
 Na 9.0 9.0 7.0  
 K 2.8 2.8 2.5  
 HCO<sub>3</sub> 175 175 182  
 SO<sub>4</sub> 23 23 21  
 NH<sub>4</sub> -- -- --  
 NO<sub>2</sub> & NO<sub>3</sub>-N .40 .63  
 PO<sub>4</sub> (Ortho) -P -- .021

Biological Character

Total Coliform  
 (colonies/100 mls)  
 Fecal Coliform 42  
 (colonies/100 mls) 2  
 Stock present



## BASIC DATA RECORD

Station: MacLean Stream Reach Score: 48  
 Location: S 23 T 1S R 9W Survey Date: 9/23/76  
 Water Year: 1977

Date	7/16	7/28	8/31	9/21	9/29
Time	1300	1530	1345	1430	1330
Temperature (F°)					
air	79	77	48	50	57
water	48	50	45	44	46
water (max)	56	52	52	50	46
water (min)	41	45	43	41	39
Precipitation (in)	n/a				
Discharge (cfs)					
instant	.74	.77	.74	.74	.72
crest stage	.82	.81	.77	.80	.74
Suspended sediment (ppm)	9	9	<5	<5	<5
Chemical Character					
PH	7.89	8.05	8.01		8.16
ALK (CaCO <sub>3</sub> ) (mg/l)	158	152	149		153
SC (µmhos)	345	302	298	304	314
TDS (mg/l)	224	196	194	198	204
Ca	38	32	40		44
Mg	15	15	17		19
Na	7.0	7.1	7.8		9.0
K	2.0	2.3	2.6		3.3
HCO <sub>3</sub>	193	185	182		187
SO <sub>4</sub>	17	22	20		22
NH <sub>4</sub>	.04	--	.01		.05
NO <sub>2</sub> & NO <sub>3</sub> -N	.57	.54	.81		.60
PO <sub>4</sub> (Ortho)-P	.042	.044	.029		.029

Biological Character

Total Coliform (colonies/100 mls)	18	67	41	15
Fecal Coliform (colonies/100 mls)	2	12	12	14
Stock present	u	y	y	y



## BASIC DATA RECORD

Station: MacLean  
 Location: S 23 T 15 R 9W  
 Water Year: 1978

Stream Reach Score: 48Survey Date: 9/23/76

Date 1977  
Time 10/15 11/10  
1315 1245

4/25 5/3 5/9  
1115 1430 1215

Temperature (F°)

air 55 41  
 water 39 34  
 water (max) 47 43  
 water (min) 36 33

Precipitation (in)

Discharge (cfs)  
 instant .74 .74  
 crest stage .80 .80

Suspended sediment (ppm)

< 5 9 19 14 24 16 17 28

Chemical Character

pH 8.05 8.03  
 ALK (CaCO<sub>3</sub>) (mg/l) 151 136  
 SC (µmhos) 320 304  
 TDS (mg/l) 208 198  
 Ca 36 44  
 Mg 17 17  
 Na 7.9 8.2  
 K 2.4 2.2  
 HCO<sub>3</sub> 184 166  
 SO<sub>4</sub> 25 20  
 NH<sub>4</sub> (.12) <.01  
 NO<sub>3</sub> 6 NO<sub>3</sub>-N .60 .17  
 PO<sub>4</sub> (Ortho)-P .020 .016

Biological Character

Total Coliform  
 (colonies/100 mls) < 2 7  
Fecal Coliform  
 (colonies/100 mls) < 2 2  
Stock present  
 y n



## BASIC DATA RECORD

Station: MacLean  
 Location: S 23 T 1S R 9W  
 Water Year: 1978

Stream Reach Score: 48Survey Date: 9/23/76

Date Time	5/15 1715	5/23 1500	5/30 1500	6/7 1400	6/14 1430	6/20 1200	6/30 1715	7/17 1415	8/15 1830
Temperature (F°)									
air	53	57	49	72	64	61	70	64	66
water	44	46	43	49	47	44	50	49	49
water (max)	46	46	48	50	51	49	51	52	51
water (min)	37	37	37	41	41	41	43	45	46

## Precipitation (in)

Discharge (cfs)									
instant	.74	.95	.92	.77	.92	.74	.70	.58	.51
crest stage	.92	1.1	1.3	1.1	.99	1.0	.88	.95	.92

## Suspended

sediment (ppm)	27	32	31	27	26	31	32	30	28
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## Chemical Character

pH	7.95					7.93		8.02	8.16
ALK (CaCO <sub>3</sub> ) (mg/l)	154					152		149	154
SC (µmhos)	312	321	322	316	315	314	348	352	339
TDS (mg/l)	203	209	209	205	205	204	226	229	220
Ca	33					33		38	40
Mg	16					17		17	15
Na									
K	7.2					7.2		7.6	6.0
HCO <sub>3</sub>	2.4					2.0		2.5	2.3
SO <sub>4</sub>	185					183		182	188
	13					19		26	25
NH <sub>4</sub>	.02					.01		.06	< .01
NO <sub>3</sub> -N	.14					.01		.23	.15
PO <sub>4</sub> (Ortho)-P	.034					.042		.041	.042

## Biological Character

Total Coliform (colonies/100 mls)	50		327					703	5500
Fecal Coliform (colonies/100 mls)	< 2		3					1	4
Stock present	n	n	n	n	y	u	y	u	u



## BASIC DATA RECORD

Station: MacLean  
 Location: S 23 T 1S R 9W  
 Water Year: 1978

Stream Reach Score: 48  
 Survey Date: 9/23/76

Date 9/12  
 Time 0945

Temperature (F°)  
 air 36  
 water 43  
 water (max) 52  
 water (min) 43

Precipitation (in)

Discharge (cfs)  
 instant .99  
 crest stage 1.1

Suspended  
 sediment (ppm) 51

## Chemical Character

pH 7.83  
 ALK (CaCO<sub>3</sub>) (mg/l) 130  
 SC (umhos) 348  
 TDS (mg/l) 226  
 Ca " 36  
 Mg " 17  
 Na " 8.6  
 K " 3.7  
 HCO<sub>3</sub> " 158  
 SO<sub>4</sub> " 26  
 NH<sub>4</sub> " <.01  
 NO<sub>3</sub> " .11  
 NO<sub>2</sub> " .042  
 PO<sub>4</sub> (Ortho)-P "

## Biological Character

Total Coliform  
 (colonies/100 mls) 2800  
 Fecal Coliform  
 (colonies/100 mls) 2  
 Stock present u





